United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with Bureau of Indian Affairs and Arizona Agricultural Experiment Station

Soil Survey of Hopi Area, Arizona, Parts of Coconino and Navajo Counties

How To Use This Soil Survey

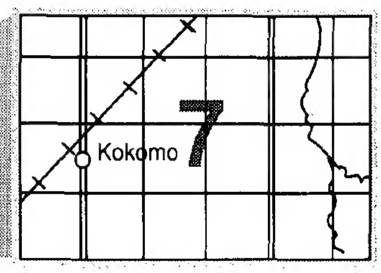
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

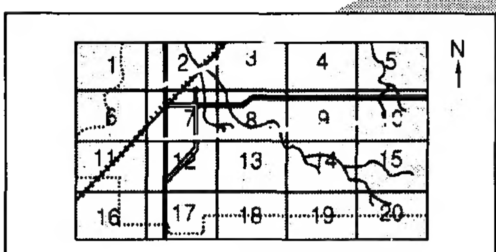
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



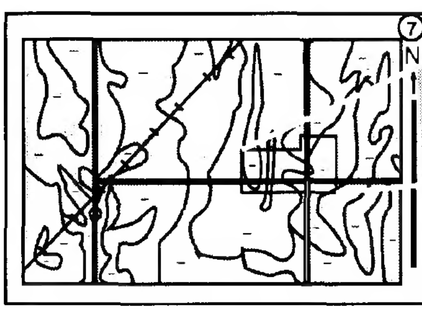
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



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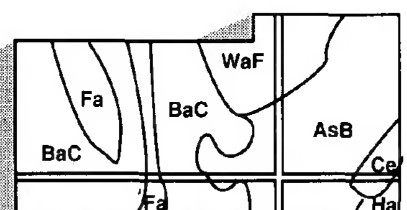

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This survey was made cooperatively by the Natural Resources Conservation Service, the Bureau of Indian Affairs, the Arizona Agricultural Experiment Station, and the Hopi Tribe.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Natural Resources Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Alkali sacaton in an area of Jocity fine sandy loam, 0 to 3 percent slopes, near the Ha Ho No Geh Canyon.

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Foreword

This soil survey contains information that affects land use planning in this survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations that affect various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

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Soil Survey of
Hopi Area, Arizona, Parts of Coconino and Navajo Counties

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United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Bureau of Indian Affairs and the Arizona Agricultural Experiment Station

The survey area is in the eastern part of Coconino County and the northern part of Navajo County in northeastern Arizona (fig. 1). It covers an area of 1,561,054 acres, or 2,439 square miles. The area includes the exclusive Hopi Indian Reservation, known as District Six, and the recently allocated Hopi Partitioned Lands of the former Navajo-Hopi Joint Use Area. The survey area is bordered on all sides by the Navajo Indian Reservation.

This survey supersedes the soils and range inventories of the Joint Use Area and the Hopi District Six Area, published by the Bureau of Indian Affairs in 1964 and 1974, respectively *(30, 31)*. The present survey updates the earlier inventories and provides greater detail of mapping and additional information regarding use and management of the soils. This survey also provides basic soils information for potentially arable land and range site data for tribal use in natural resource management decisions. At the time this report was written, no other published soil survey adjoined the Hopi soil survey area.

Soil scientists have mapped about 30 different kinds of soils in the survey area. The northern section of the area consists of the high plateaus and escarpments of Black Mesa. The shallow Kydestea, Zyme, and Travessilla soils dominate the steep slopes and mesa edges. The deep, loamy Penistaja and Begay soils are the major soils on the undulating plateaus. The southern lowlands are wide alluvial valleys mantled with eolian sands. The main soils in these areas are Sheppard, Monue, and Nakai soils. Jocity, Ives, and

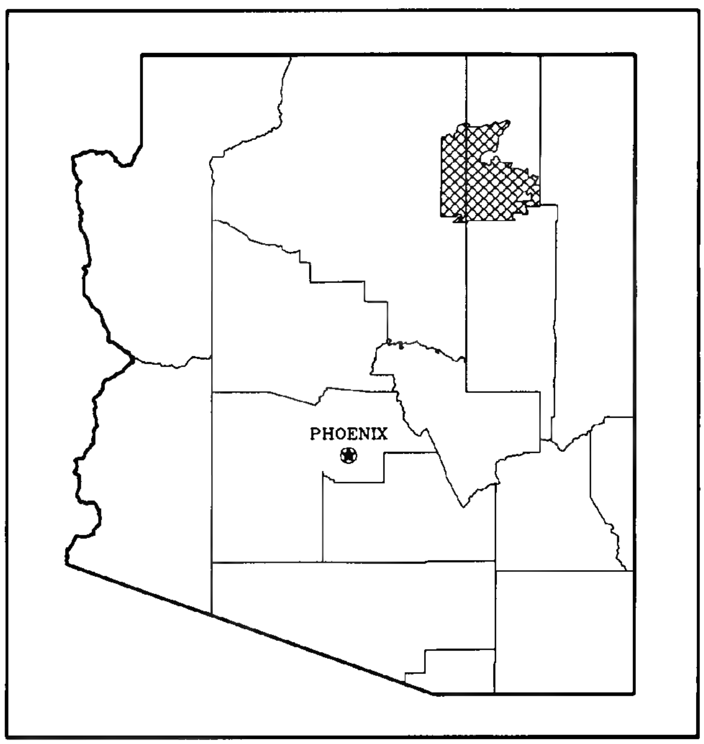

Figure 1.—Location of the survey area in Arizona.

Tewa soils also occupy large areas on flood plains, alluvial fans, stream terraces, and fan terraces. Soils that have potential for irrigated cropland were mapped in greater detail than nonarable soils.

Approximately 38,500 acres of sacred and traditional land near the villages on Second Mesa and Third Mesa were not accessible to the soil scientists. These areas were mapped using knowledge of the surrounding area and by interpretation of aerial photographs. The delineations in these areas are differentiated by a dashed boundary line and labeled "Traditional Lands" and are less accurate than those in areas where soil scientists had access to the land and could examine the soils.

General Nature of the Survey Area

This section briefly describes the physiography, history and development, natural resources, transportation facilities, and climate of the survey area.

Physiography

The elevation of the survey area ranges from 4,800 feet in the southwestern part to 6,800 feet on Big Mountain in the northern part. The northern part consists of the high, steep-sided plateau of Black Mesa and its southwestward extensions, which, in order from east to west, are Antelope Mesa, First Mesa, Second Mesa, and Third Mesa. The plateaus are capped by the sedimentary Mesa Verde Group, which overlies the Mancos Shale *(21)*. Numerous springs occur at the contact of these formations near the tips of the Hopi Mesas. Villages are clustered around these points.

The extending Hopi Mesas are separated by deeply entrenched ephemeral drainageways that flow to the southwest toward the Little Colorado River. The major drainageways are Jeddito, Wepo, Polacca, Oraibi, and Dinnebito Washes. Great quantities of sediments are transported across the wide alluvial valleys of the southern section and redistributed upstream by eolian processes *(15)*.

History and Development

The Hopis are descendants of the ancient Anasazi Indians, whose culture dates back to 100 A.D. *(26)*. The Hopi Mesas have been inhabited for more than a thousand years. Oraibi, which was constructed around 1150 A.D., is the oldest continually inhabited settlement in the United States.

Pedro de Tovar, sent by Coronado in 1540 to seek the seven cities of gold, was the first European explorer to visit the Hopi country. The land was part of the Spanish province of New Mexico until 1823. During this time, the Navajo Indians migrated into the area from the northwest. In 1848, the treaty of Guadalupe Hidalgo established the American territory of New Mexico, followed shortly by the American gold rush and the westward expansion. To protect the Hopi Indians from further encroachment, President Chester A. Arthur set aside nearly 4,000 square miles for their use under the 1882 Executive Order. This area encompassed the Hopi District Six and the former Navajo-Hopi Joint Use Area. In 1974, the Navajo-Hopi Land Settlement Act provided for equal partitionment of the Joint Use Area.

The population of the survey area is about 9,000. The inhabitants are clustered mainly in autonomous villages near the tips of mesas. Scattered Navajo family units are presently located on the partitioned lands. The Hopis are a pueblo-agricultural tribe, and specialized dryland farming has been their traditional subsistence until modern times. Tribal and Federal governments now provide one-half of all employment on the reservation. Other sources of income include small businesses, cattle and sheep enterprises, agriculture, mining, tourism, and crafts *(6)*.

Natural Resources

Soil is the most important resource in the survey area. Deep soils, abundant eolian sand, and wide alluvial valleys provided an excellent location for agricultural settlement by the Anasazi. Traditional dryland farming and more recent ranching enterprises depend on the soil for food and forage production. Coal is mined from the Wepo Formation in the northern partitioned lands, and deposits occur at other locations in the Dakota Sandstone and the Mesa Verde Group. Other mineral resources include small areas of limestone, bentonite, bleaching and structural clays, and various construction materials *(21)*. At the higher elevations, the pinyon-juniper woodland provides a good source of fuel wood.

Transportation Facilities

Three state highways currently serve the survey area. They are Arizona Highway SR-77, running north and south between Holbrook and Keams Canyon; Arizona Highway SR-87, between Winslow and Second Mesa; and Arizona Highway SR-264, running east and west. Access to Interstate 40 is 40 miles south at Winslow or Holbrook. The Turquoise Highway crosses Black Mesa. A small, lighted and paved airstrip is located near Polacca, and commercial air service is available at Winslow. The nearest railroad is also at Winslow *(6)*.

Climate

Summers are hot in the survey area, especially at the lower elevations, and winters are cold. Precipitation is normally light at the lower elevations throughout the year. At the higher elevations, precipitation is much greater and snow accumulates to considerable depths. Much of the snowmelt irrigates crops in nearby valleys.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Keams Canyon in the period 1954 to 1985. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 32 degrees F and the average daily minimum temperature is 18 degrees. The lowest temperature on record, which occurred on January 30, 1979, is -25 degrees. In summer, the average temperature is 70 degrees and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred on July 15, 1976, is 104 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 11 inches. Of this, about 5 inches, or 45 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 3 inches. The heaviest 1-day rainfall during the period of record was 3.05 inches on August 28, 1972. Thunderstorms occur on about 50 days each year.

The average seasonal snowfall is about 11 inches. The greatest snow depth at any one time during the period of record was 12 inches. On the average, 11 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 40 percent. Humidity is higher at night, and the average at dawn is about 70 percent. The sun shines 85 percent of the time possible in summer and 75 percent in winter. The prevailing wind is from the south-southwest. Average windspeed is highest, 9 miles per hour, in spring.

Every few years a blizzard strikes the survey area with high winds and drifting snow. Even at the lower elevations, snow remains on the ground for many weeks and causes suffering to livestock.

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the

arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on rangeland productivity and characteristic plant communities were assembled for this survey by a range conservationist who measured range production on the various soils.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The components of one map unit can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Jocity-Polacca-Wepo

Deep, well drained, nearly level, loamy, loamy over sandy, and clayey soils; on stream terraces, alluvial fans, and flood plains

This map unit is adjacent to Dinnebito, Jeddito, Oraibi, and Polacca Washes. Slopes range from 0 to 3 percent. The present vegetation is mainly alkali sacaton, galleta, bottlebrush squirreltail, and fourwing saltbush. Elevation is 4,800 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit makes up about 8 percent of the survey area.

Jocity and similar soils are on alluvial fans and flood plains. They formed in alluvium derived from sedimentary rock. They are stratified and loamy to a depth of 60 inches or more.

Polacca soils are on stream terraces. They formed in alluvium derived from sedimentary rock. They are loamy to a depth of 33 inches. Below this to a depth of 60 inches or more is sandy material.

Wepo soils are on stream terraces. They formed in alluvium derived from sedimentary rock. They are clayey to a depth of 60 inches or more.

Of minor extent in this unit are Ives, Jeddito, and Naha soils.

This unit is used mainly for grazing. A few scattered areas are used for dryland farming. These soils could be used for irrigated crops if water becomes available. The soils are subject to water erosion, which is particularly pronounced in areas adjacent to washes (fig. 2).

2. Jeddito-Tewa

Deep, somewhat excessively drained and well drained, nearly level and gently sloping, loamy soils; on fan terraces and stream terraces

This map unit is in the central part of the survey area. Slopes range from 0 to 5 percent. The present vegetation on the Jeddito soils is mainly Indian ricegrass, galleta, blue grama, and fourwing saltbush. The present vegetation on the Tewa soils is mainly galleta, Indian ricegrass, western wheatgrass, alkali sacaton, and fourwing saltbush. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit makes up about 5 percent of the survey area.

Jeddito and similar soils are on fan terraces and stream terraces. Slopes range from 0 to 5 percent. These soils are deep and somewhat excessively drained. They formed in alluvium derived from sedimentary rock. They are loamy to a depth of 60 inches or more and have strata of sand, loamy sand, very fine sandy loam, and clay.

Tewa soils are well drained and are on stream terraces. Slopes range from 1 to 5 percent. These soils formed in alluvium derived from sedimentary rock. They are loamy to a depth of 60 inches or more.

Of minor extent in this unit are Cannonville, Jocity, Monue, and Naha soils.

This unit is used mainly for grazing. A few scattered

Figure 2.—Erosion in a wash adjacent to an area of the Jocity-Polacca-Wepo general soil map unit.

areas are used for dryland farming. These soils could be used for irrigated crops if water becomes available. The hazard of soil blowing is severe.

3. Sheppard-Monue-Nakai

Deep, somewhat excessively drained and well drained, nearly level to strongly sloping, sandy and loamy soils; on dunes, fan terraces, and plateaus

This map unit makes up a large portion of the southern and western parts of the survey area. Slopes range from 1 to 15 percent. The vegetation is mainly Indian ricegrass, blue grama, galleta, and Cutler Mormon tea. Elevation is 4,800 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit makes up about 52 percent of the survey area.

Sheppard and similar soils are somewhat excessively drained and are on dunes. Slopes range from 1 to 15 percent. These soils formed in eolian sands. They are sandy to a depth of 60 inches or more.

Monue soils are well drained and are on fan terraces and plateaus. Slopes range from 1 to 8 percent. These soils formed in loamy eolian deposits. They are loamy to a depth of 60 inches or more.

Nakai soils are well drained and are on fan terraces and plateaus. Slopes range from 1 to 15 percent. These soils formed in eolian deposits over alluvium derived from sandstone and shale. They are loamy to a depth of 60 inches or more.

Of minor extent in this unit are Jeddito and Tewa soils.

This unit is used for grazing. A few scattered areas are used for dryland farming. These soils could be used for irrigated crops if water becomes available.

The soils in this unit are among the more productive rangeland soils in the area. The hazard of soil blowing is severe.

4. Sheppard-Jocity

Deep, somewhat excessively drained and well drained, nearly level to strongly sloping, sandy and loamy, sodic soils; on dunes, flood plains, and alluvial fans

This map unit is in the extreme southwest part of the survey area. Slopes range from 0 to 8 percent. The present vegetation on the Sheppard soils is mainly alkali sacaton, Indian ricegrass, galleta, and fourwing saltbush. The present vegetation on the Jocity soils is mainly alkali sacaton, galleta, mound saltbush, and black greasewood. Elevation is 4,800 to 5,300 feet. The mean annual precipitation is 6 or 7 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit makes up about 1 percent of the survey area.

Sheppard soils are somewhat excessively drained and are on dunes. Slopes range from 1 to 8 percent. These soils formed in eolian sands. They are sandy to a depth of 60 inches or more.

Jocity and similar soils are well drained and are on flood plains and alluvial fans. Slopes range from 0 to 3 percent. These soils formed in mixed alluvium derived from sedimentary rock. They are loamy to a depth of 60 inches or more.

Of minor extent in this unit are Ives, Jeddito, Joraibi, Naha, and Wepo soils and Torriorthents. All of these minor soils have moderate amounts of sodium.

This unit is used for grazing. These soils could be used for irrigated crops if water becomes available and the soils are reclaimed.

5. Strych-Kinan

Deep, well drained and somewhat excessively drained, nearly level to very steep, cobbly and gravelly, loamy soils; on mesas, buttes, and fan terraces

This map unit is in the southeastern part of the survey area along the Hopi Buttes. Slopes range from 2 to 60 percent. The present vegetation on the Strych soils is mainly muttongrass, black grama, green Mormon tea, and Bigelow sagebrush. The present vegetation on the Kinan soils is mainly black grama, blue grama, Indian ricegrass, and galleta. Elevation is 5,500 to 6,700 feet. The mean annual precipitation is 6 to 14 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit makes up about 1 percent of the survey area.

Strych and similar soils are well drained and are on mesas and buttes. Slopes range from 25 to 60 percent. These soils formed in colluvium and eolian deposits derived from sedimentary rocks. The surface layer is loamy and is 60 to 75 percent pebbles and cobbles. The subsoil is loamy and is 40 to 65 percent cobbles and stones.

Kinan and similar soils are somewhat excessively drained and are on fan terraces. Slopes range from 2 to 12 percent. These soils formed in eolian deposits and alluvium derived from sedimentary rocks. The surface layer is loamy and is 0 to 50 percent cobbles and pebbles. The upper 29 inches of the subsoil is loamy. The lower part to a depth of 60 inches or more is sandy. The content of rock fragments ranges from 5 to 50 percent in individual horizons.

Of minor extent in this unit are Mido, Monue, and Sheppard soils and areas of rock outcrop.

This unit is used for grazing.

6. Torriorthents-Badland-Rock Outcrop

Badland, rock outcrop, and shallow to deep, well drained, nearly level to very steep, loamy and clayey soils; on highly dissected hills

This map unit is predominantly in Ha Ho No Geh Canyon, Bat Canyon, and Coal Mine Canyon (fig. 3). Slopes range from 1 to 60 percent. The present vegetation on the Torriorthents is mainly galleta, Indian ricegrass, shadscale, and Bigelow sagebrush. Elevation is 4,900 to 6,800 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit makes up about 4 percent of the survey area.

Torriorthents are on dissected hills. These soils are shallow to deep and are well drained. They formed in sedimentary rock. They are loamy or clayey throughout.

Badland consists of severely eroded barren land that is dissected by many small intermittent drainageways.

Rock outcrop consists of barren exposures of sedimentary rock.

Of minor extent in this unit are Jeddito, Jocity, and Wepo soils.

This unit has very limited use. It is sometimes used for grazing.

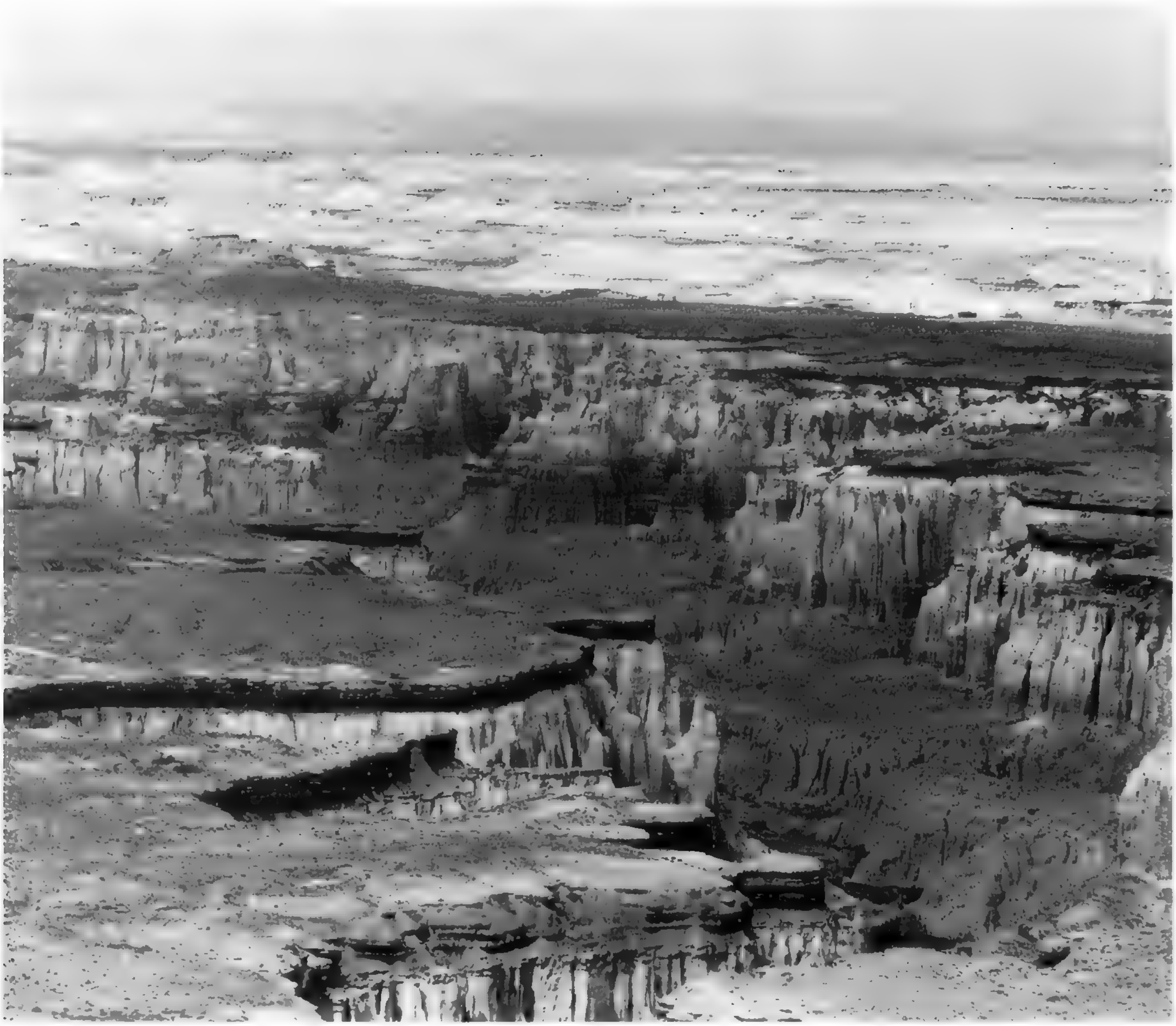

Figure 3.—An area of the Torriorthents-Badland-Rock outcrop general soil map unit in Coal Mine Canyon. (Photo by Fred Kootswatewa, Hopi Tribe)

7. Begay-Penistaja-Mido

Deep, well drained and excessively drained, nearly level to strongly sloping, sandy and loamy soils; on plateaus and dunes

This map unit is on Black Mesa in the north-central part of the survey area. Slopes range from 1 to 15 percent. The present vegetation is mainly needleandthread, Indian ricegrass, blue grama, and Cutler Mormon tea. Elevation is 5,800 to 6,800 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 50 to 53 degrees F, and the frost-free period is 120 to 150 days.

This unit makes up about 14 percent of the survey area.

Begay soils are well drained and are on plateaus.

Slopes range from 1 to 8 percent. These soils formed in eolian deposits. They are loamy to a depth of 60 inches or more.

Penistaja soils are well drained and are on plateaus. Slopes range from 1 to 8 percent. These soils formed in eolian deposits and alluvium. They are loamy to a depth of 60 inches or more.

Mido soils are excessively drained and are on dunes. Slopes range from 1 to 15 percent. These soils formed in eolian deposits. They are sandy to a depth of 60 inches or more.

Of minor extent in this unit are Kydestea, Milok, Travessilla, and Zyme soils.

This unit is used mainly for grazing. A few scattered areas are used for dryland farming. These soils could be used for irrigated crops if water becomes available.

This unit has the best potential in the survey area for range seeding.

8. Kydestea-Zyme-Tonalea

Very shallow to moderately deep, well drained and excessively drained, gently sloping to steep, channery, loamy, clayey, and sandy soils; on hills and dunes

This map unit is on Black Mesa in the northern part of the survey area. Slopes range from 5 to 50 percent. The present vegetation on the Kydestea and Tonalea soils is mainly Utah juniper, pinyon pine, Indian ricegrass, and Stansbury cliffrose. The present vegetation on the Zyme soils is mainly galleta, alkali sacaton, bottlebrush squirreltail, and shadscale. Elevation is 5,900 to 6,800 feet. The mean annual precipitation is 12 to 14 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

This unit makes up 15 percent of the survey area.

Kydestea soils are on hills. They are very shallow and shallow and are well drained. Slopes range from 5 to 50 percent. The soils formed in alluvium and colluvium derived from sedimentary rock. The surface layer is loamy and is 35 to 50 percent channers. The underlying material, to a depth of 15 inches, is loamy and is 35 to 65 percent channers. Sandstone bedrock is at a depth of 15 inches.

Zyme soils are on hills. They are very shallow and shallow and are well drained. Slopes range from 5 to 50 percent. The soils formed in alluvium derived from shale. They are clayey to a depth of 18 inches. Shale bedrock is at a depth of 18 inches.

Tonalea soils are on dunes. They are moderately deep and are excessively drained. Slopes range from 5 to 20 percent. The soils formed in eolian deposits. They are sandy to a depth of 24 inches. Sandstone bedrock is at a depth of 24 inches.

Of minor extent in this unit are Begay, Penistaja, Mido, and Travessilla soils and areas of rock outcrop.

This unit is used as grazable woodland or for firewood harvesting. It produces the most fuel wood in the survey area.

Detailed Soil Map Units

The map units delineated on the detailed maps at the back of this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information about each map unit is given under the heading "Use and Management of the Soils."

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Sheppard loamy sand, 1 to 15 percent slopes, is a phase of the Sheppard series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are called complexes. A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of

the soils or miscellaneous areas are somewhat similar in all areas. Sheppard-Monue complex, 1 to 8 percent slopes, is an example.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Dune land is an example.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

Soil Descriptions

1—Bacobi fine sandy loam, 1 to 5 percent slopes. This moderately deep, well drained soil is on fan terraces and pediments. It formed in eolian deposits over soft sedimentary rocks. Elevation is 5,300 to 5,900 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 55 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is light brown fine sandy loam about 2 inches thick. The upper 13 inches of the subsoil is brown very fine sandy loam and fine sandy loam. The lower part is brown sandy clay loam and fine sandy loam about 21 inches thick. Soft sedimentary rock is at a depth of 36 inches. In some areas the surface layer is very fine sandy loam or loamy fine sand. The depth to soft sedimentary rock ranges from 20 to 39 inches.

Included in mapping are small areas of soils that are similar to the Bacobi soil on fan terraces but have a high content of lime in the subsoil, soils that are similar to the Bacobi soil but are shallow, and areas of Sheppard soils on dunes. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is moderately slow in the Bacobi soil. Available water capacity is moderate. Potential rooting depth is 20 to 39 inches. The hazard of soil blowing is severe. The sodium adsorption ratio ranges from 7 in the upper part of the subsoil to 15 in the lower part.

This soil is used for grazing. It is poorly suited to the production of wild herbaceous plants, shrubs, and vines for wildlife habitat. Areas of this soil can be used as irrigated cropland if water becomes available, but the shallow depth to bedrock and the content of sodium are limitations affecting crop production in some areas.

The potential plant community is mainly galleta, alkali sacaton, Indian ricegrass, bottlebrush squirreltail, and shadscale. If the range is improperly used, galleta, shadscale, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, sixweeks fescue and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Overgrazing reduces the plant cover and increases the risk of erosion. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are areas of shallow soils, low precipitation, and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Graded furrow, graded border, sprinkler, or drip irrigation systems are suitable on this soil. Sprinkler irrigation systems are especially effective in the more sloping areas. Because the available water capacity is only moderate, water should be applied at more frequent intervals. Crops that are tolerant of sodium should be selected. Applying gypsum and adequately leaching the salts from the root zone can help to reclaim the soil. The hazard of erosion can be reduced by returning crop residue to the soil and minimizing tillage. If the land is leveled, using only shallow cuts helps to prevent exposing the soft bedrock.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Shale Upland, 6- to 10-inch precipitation zone.

2—Badland-Torriorthents complex, 8 to 50 percent slopes. This map unit is on hills and mesa escarpments (fig. 4). Slopes are complex. Elevation is 4,900 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit is 70 percent Badland and 20 percent Torriorthents. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in mapping are small areas of Epikom soils on mesas and plateaus, Ives soils on flood plains,

Figure 4.—An area of Badland-Torriorthents complex, 8 to 50 percent slopes. This map unit supports little vegetation.

Jocity soils on flood plains and alluvial fans, Wepo soils on stream terraces, and Sheppard soils on dunes. Also included are areas of rock outcrop on escarpments. Included areas make up about 10 percent of the unit. The percentage varies from one area to another.

Badland consists of actively eroding, barren land that is dissected by many intermittent drainageways. The material is mainly soft shale and mudstone. The hazard of water erosion is moderate.

Torriorthents are shallow to deep and are well drained. They formed in alluvium and colluvium derived dominantly from soft shale and sandstone. The texture of the surface layer varies considerably. The surface layer is moderately alkaline or strongly alkaline, nonsaline to moderately saline loamy sand, sandy loam, clay loam, or clay 1 to 9 inches thick. The next layer also is variable. It ranges from moderately alkaline, nonsaline sandy loam to strongly alkaline, moderately saline clay 6 to 30 inches thick. The underlying material is moderately alkaline or strongly alkaline, nonsaline to moderately saline sandy loam, clay loam, or clay that is underlain by sandstone, mudstone, or soft shale.

Permeability is variable in the Torriorthents, ranging from moderately rapid to slow. Potential rooting depth is 10 to 50 inches. The hazard of soil blowing is moderate or severe.

This unit has very limited potential for any use. It does, however, have esthetic value.

The soils in this unit are poorly suited to the production of wild herbaceous plants, shrubs, and vines for wildlife habitat.

The present vegetation in a few areas consists mainly of sparse stands of alkali sacaton, bottlebrush squirreltail, galleta, Indian ricegrass, mound saltbush,

golden buckwheat, and shadscale.

The capability subclass is VIIIe. No range site is assigned.

3—Bighams very fine sandy loam, 1 to 8 percent slopes. This moderately deep, well drained soil is on plateaus and hills. It formed in eolian deposits over alluvium derived dominantly from sandstone and shale. Elevation is 6,300 to 6,700 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

Typically, the surface layer is brown very fine sandy loam about 2 inches thick. The upper 15 inches of the subsoil is brown fine sandy loam. The lower 18 inches is light brown and white sandy clay loam. Partially weathered sandstone and shale bedrock is at a depth of 35 inches. The depth to weathered sedimentary rock ranges from 24 to 40 inches. In some areas, the surface layer is loamy fine sand and the depth to weathered bedrock is more than 40 inches.

Included in mapping are small areas of Begay soils on plateaus and Mido soils on dunes. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is moderate in the Bighams soil. Available water capacity also is moderate. Potential rooting depth is 24 to 40 inches. The hazard of soil blowing is severe. The content of lime ranges from 15 to 40 percent in some part of the root zone.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat but is poorly suited to the production of coniferous trees. This soil can be used for irrigated crops if water becomes available, but the shallow depth to bedrock is a limitation affecting crop production.

The potential plant community is mainly needleandthread, Indian ricegrass, blue grama, galleta, gray horsebrush, Utah juniper, and pinyon. If the range is improperly used, galleta, bottlebrush squirreltail, Utah juniper, pinyon, and Stansbury cliffrose increase. If the vegetation is allowed to deteriorate further, sixweeks fescue, cheatgrass, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are looseness of the soil and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Graded furrow and graded border irrigation systems work well in the less sloping areas, and sprinkler irrigation systems are effective in the more sloping areas. Because the available water capacity is only moderate, water should be applied at more frequent intervals. If land smoothing is needed, making only shallow cuts helps to prevent exposing the soft sedimentary rock and the part of the soil that has a high content of lime. The hazard of erosion can be reduced by returning crop residue to the soil and minimizing tillage. Lime in the subsoil causes chlorosis in some plants. Chlorosis can be prevented by applying soil amendments or plant sprays.

The capability subclass is IIIe, irrigated, and VIe, nonirrigated. The range site is Sandy Loam Upland, 10- to 14-inch precipitation zone.

4—Cannonville clay loam, 15 to 50 percent slopes. This very shallow and shallow, well drained soil is on hills. It formed in alluvium and residuum derived dominantly from soft shale. Elevation is 5,700 to 6,300 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

Typically, the surface layer is light yellowish brown clay loam about 2 inches thick. The subsoil is yellowish brown clay loam about 3 inches thick. The upper 3 inches of the substratum is yellowish brown clay. The lower part, to a depth of 12 inches, is variegated light yellowish brown, light brownish gray, and white clay loam. Partially weathered and highly fractured shale is at a depth of about 12 inches. The depth to weathered shale ranges from 7 to 20 inches. In some areas the slope is less than 15 percent.

Included in mapping are small areas of badland on steep slopes. Also included are Jocity soils on flood plains and alluvial fans and Wepo soils on stream terraces. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is slow in the Cannonville soil. Available water capacity is very low. Potential rooting depth is 7

to 20 inches. The hazard of soil blowing is slight. The sodium adsorption ratio is less than 5 in the subsoil but commonly ranges to 10 in the substratum. The shrink-swell potential is high.

This unit is used for grazing. It is poorly suited to the production of wild herbaceous plants and shrubs for wildlife habitat.

The potential plant community is mainly alkali sacaton, galleta, Indian ricegrass, bottlebrush squirreltail, shadscale, Bigelow sagebrush, and dwarf rabbitbrush. If the range is improperly used, galleta, Torrey seepweed, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Properly locating salt and livestock watering facilities promotes uniform distribution of livestock grazing. Seeding generally is not practical because of the slope, rough terrain, surface crusting, and the very low available water capacity. The slope limits access by livestock and results in overgrazing in the less sloping areas.

The capability subclass is VIIe. The range site is Clayey Slopes, 10- to 14-inch precipitation zone.

5—Doak-Monue complex, 1 to 6 percent slopes. This map unit is on fan terraces. Elevation is 5,100 to 5,600 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit is 55 percent Doak fine sandy loam, 1 to 3 percent slopes, and 30 percent Monue very fine sandy loam, 1 to 6 percent slopes. The two soils are so intermingled that it was not practical to map them separately at the scale used. The Monue soil is in the higher, hummocky areas, and the Doak soil is in the lower, loamy areas.

Included in mapping are small areas of Jocity soils on flood plains and alluvial fans, Sheppard soils on dunes, and Wepo soils on stream terraces. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

The Doak soil is deep and well drained. It formed in eolian deposits over alluvium derived dominantly from sandstone and shale. Typically, the surface layer is reddish brown fine sandy loam about 3 inches thick. The upper 12 inches of the subsoil also is reddish brown fine sandy loam. The next 18 inches is reddish brown sandy clay loam. The lower part of the subsoil is about 14 inches of light reddish brown fine sandy loam that has thin strata of gravelly clay. Weathered shale is at a depth of 47 inches. The depth to weathered shale ranges from 40 to 60 inches. In some areas the surface layer is clay loam. In other areas the depth to weathered shale is more than 60 inches.

Permeability is moderately slow in the Doak soil. Available water capacity is moderate. Potential rooting depth is 40 to 60 inches. The hazard of soil blowing is severe.

The Monue soil is deep and well drained. It formed in loamy eolian deposits derived dominantly from sandstone. Typically, the surface layer is reddish brown very fine sandy loam about 1 inch thick. The subsoil is reddish brown, yellowish red, and light reddish brown fine sandy loam about 45 inches thick. The substratum to a depth of 84 inches or more is reddish brown and yellowish red loamy fine sand. In some areas the surface layer is loamy fine sand.

Permeability is moderately rapid in the Monue soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants, shrubs, and vines for wildlife habitat. It can be used as irrigated cropland if water becomes available.

The potential plant community on the Doak soil is mainly alkali sacaton, galleta, Indian ricegrass, and broom snakeweed. If the range is improperly used, galleta and broom snakeweed increase. If the vegetation is allowed to deteriorate further, Russian-thistle, cheatgrass, and other forbs invade.

The potential plant community on the Monue soil is mainly Indian ricegrass, blue grama, galleta, Cutler Mormon tea, and needleandthread. If the range is improperly used, galleta, Fendler threeawn, broom snakeweed, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Overgrazing reduces the plant cover and increases the risk of erosion. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation and the hazard of erosion following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Graded furrow, graded border, sprinkler, or drip irrigation systems are suitable. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Sprinkler irrigation systems work well in the more sloping areas. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients in areas of the Monue soil. In irrigated areas, careful applications are needed to prevent the development of a perched water table on the shale below the Doak soil. Maintaining crop residue on or near the surface helps to control runoff, helps to control soil blowing, and helps to maintain soil tilth and the content of organic matter.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site of the Doak soil is Clay Fan, 6- to 10-inch precipitation zone, and that of the Monue soil is Sandy Loam Upland, 6- to 10-inch precipitation zone.

6—Dune land. This map unit consists of deep, excessively drained, active sand dunes. It is on mesas, plateaus, stream terraces, and fan terraces. It consists of ridges and troughs of sand-sized particles that shift with the wind. Elevation is 5,000 to 6,200 feet. Areas of this unit are barren.

Included in mapping are small areas of Mido and Sheppard soils. These soils are in stable, vegetated areas adjacent to or between the dunes. They make up about 10 percent of the unit.

This unit is not suited to the production of vegetation for wildlife habitat.

The capability subclass is VIIIe. No range site is assigned.

7—Epikom very gravelly fine sandy loam, 1 to 5 percent slopes. This shallow, well drained, sodic soil is on edges of mesas and plateaus. It formed in thin eolian deposits over alluvium and residuum derived dominantly from sedimentary rock. Elevation is 5,000 to 5,400 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, about 60 percent of the surface is covered with wind-polished chert pebbles. The surface layer is reddish brown very gravelly fine sandy loam about 1 inch thick. The upper 12 inches of the subsoil is yellowish red and reddish brown fine sandy loam and loam. The lower 4 inches is light reddish brown gravelly loam. Sandstone is at a depth of about 17 inches. In some areas the surface layer is sandy clay loam or clay loam. The depth to bedrock ranges from 10 to 20 inches. In a few areas the depth to bedrock is less than 10 inches.

Included in mapping are small areas of soils that have a subsoil of clay loam and a high content of lime. Included areas make up about 10 percent of the unit. The percentage varies from one area to another.

Permeability is moderately rapid in the Epikom soil. Available water capacity is very low. Potential rooting depth is 10 to 20 inches. The hazard of soil blowing is slight. The sodium adsorption ratio ranges from 9 to 15 and is commonly highest in the surface layer.

This unit is used for grazing. It is poorly suited to the production of wild herbaceous plants and shrubs for wildlife habitat.

The potential plant community is mainly galleta, alkali sacaton, Indian ricegrass, mound saltbush, and Torrey Mormon tea. If the range is improperly used, alkali sacaton, mound saltbush, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Properly located salt and livestock watering facilities promote uniform distribution of livestock grazing. Seeding is generally not practical because of low precipitation, excessive gravel, the content of sodium, and the very low available water capacity.

The capability subclass is VIIs. The range site is Sandstone Upland, 6- to 10-inch precipitation zone.

8—Hano fine sandy loam, 2 to 10 percent slopes. This deep, well drained soil is on highly dissected foot slopes of pediments. It formed in thin eolian deposits over alluvium and residuum derived dominantly from shale and sandstone. Elevation is 5,700 to 6,100 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 130 to 150 days.

Typically, the surface layer is brown fine sandy loam about 3 inches thick. The upper 5 inches of the subsoil is strong brown clay loam. The lower 14 inches is predominantly light yellowish brown and brown clay and clay loam. The upper 9 inches of the substratum is pale brown and brown clay that contains about 30 percent soft shale fragments. The lower part, to a depth of 42 inches, is variegated light gray, light yellowish brown, and grayish brown clay that contains about 75 percent soft shale fragments. Highly fractured, weathered shale is at a depth of about 42 inches. In some areas the surface layer is very fine sandy loam or sandy clay loam. The depth to weathered shale ranges from 40 to 55 inches. In the steeper areas the depth to weathered shale is less than 40 inches.

Included in mapping are small areas of Begay soils on plateaus, Cannonville soils on hills, and Mido soils on dunes. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is slow in the Hano soil. Available water capacity is moderate. Potential rooting depth is 40 to 55 inches. The hazard of soil blowing is severe. The sodium adsorption ratio ranges from 5 to 12 in the substratum.

This soil is used for grazing. Numerous entrenched drainageways make cultivation impractical. The soil is moderately suited to the production of wild herbaceous plants, shrubs, and vines for wildlife habitat. Winterfat and fourwing saltbush can improve the potential for wildlife habitat.

The potential plant community is mainly galleta, alkali sacaton, Indian ricegrass, bottlebrush squirreltail, shadscale, winterfat, and fourwing saltbush. If the range is improperly used, galleta, broom snakeweed, and winterfat increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Overgrazing reduces the plant cover and increases the risk of erosion. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are the numerous entrenched drainageways, the hazard of water erosion, and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

The capability subclass is VIe. The range site is Sandy Loam Upland (Saline), 10- to 14-inch precipitation zone.

9—Ives fine sandy loam, 0 to 2 percent slopes. This deep, somewhat excessively drained, stratified soil is on flood plains. It formed in alluvium derived dominantly from sandstone and shale. Elevation is 4,900 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is light yellowish brown fine sandy loam about 3 inches thick. The underlying material to a depth of 84 inches or more is light yellowish brown fine sandy loam that has thin, discontinuous strata of finer or coarser material. In some areas the surface layer is clay loam.

Included in mapping are small areas of Jocity soils on flood plains, Naha and Polacca soils on stream terraces, and Sheppard soils on dunes. Also included, in the extreme southwest part of the survey area, are small areas of Ives soils that have a moderate content of sodium. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is moderate in the Ives soil. Available water capacity also is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe. This soil is subject to frequent, brief periods of flooding in early spring and summer (fig. 5).

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs. It is poorly suited to the production of riparian shrubs, trees, vines, and herbaceous plants for wildlife habitat. A few areas are used for dryland farming. This unit can be used as irrigated cropland if water becomes available.

The potential plant community is mainly Indian ricegrass, western wheatgrass, bottlebrush squirreltail, sand dropseed, alkali sacaton, and fourwing saltbush. Most areas are presently barren. If the range is improperly used, sand dropseed, broom snakeweed, Greene rabbitbrush, and fourwing saltbush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, Russian-thistle, saltcedar, and annual forbs invade.

Figure 5.—Debris from floodwater in an area of Ives fine sandy loam, 0 to 2 percent slopes.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Overgrazing increases the risk of soil blowing. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation and the hazards of soil blowing and flooding following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. The risk of flooding can be reduced by using dikes and diversions. Furrow, border, basin, and sprinkler irrigation systems are suited to this soil. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Sprinkler irrigation systems work well on this soil. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind and

by maintaining crop residue on the surface. A cropping system that includes a close-growing, high-residue crop in the rotation helps to control soil blowing and improves soil tilth and the content of organic matter.

The capability subclass is IVw, irrigated, and VIIw, nonirrigated. The range site is Sandy Bottom, 6- to 10-inch precipitation zone.

10—Jeddito loamy sand, 0 to 5 percent slopes. This deep, somewhat excessively drained soil is on stream terraces and fan terraces. It formed in mixed alluvium derived dominantly from sandstone and shale. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is light yellowish brown loamy sand about 2 inches thick. The upper part of the underlying material is light yellowish brown fine sandy loam about 7 inches thick. The next 18 inches is light yellowish brown loamy sand, sand, and coarse sand that has thin clay lenses. The lower part to a depth of 84 inches or more is light yellowish brown fine sandy loam that has thin strata of finer and coarser material. Some areas have strata of reddish brown fine sandy loam. Other areas are not stratified.

Included in mapping are small areas of Jocity soils on flood plains and alluvial fans and Naha, Wepo, and deep, sandy soils on stream terraces. Also included, in the extreme southwest part of the survey area, are a few small areas of Jeddito soils that have a moderate amount of sodium. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is moderately rapid in the Jeddito soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs. It is poorly suited to the production of riparian shrubs, trees, vines, and herbaceous plants for wildlife habitat. A few areas are used for dryland farming. This unit can be used as irrigated cropland if water becomes available.

The potential plant community is mainly Indian ricegrass, galleta, blue grama, bottlebrush squirreltail, fourwing saltbush, and winterfat. If the range is improperly used, galleta, Fendler threeawn, broom snakeweed, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, Russian-thistle, and other annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Overgrazing increases the risk of soil blowing. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Graded furrow, graded border, drip, and sprinkler irrigation systems are suitable on this soil. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Sprinkler irrigation works well in the more sloping areas. If furrow irrigation is used, water should be applied at frequent intervals and runs should be short because of the low available water capacity and a high intake rate. Soil blowing can be controlled by returning crop residue to the soil and minimizing tillage. Keeping the surface moist during the spring reduces the hazard of soil blowing. Stripcropping or using a crop rotation that includes a close-growing cover crop also helps to control soil blowing.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Sandy Terrace, 6- to 10-inch precipitation zone.

11—Jocity fine sandy loam, 0 to 3 percent slopes. This deep, well drained, stratified soil is on alluvial fans. It formed in alluvium derived dominantly from shale and sandstone. Elevation is 4,800 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is yellowish brown fine

sandy loam about 3 inches thick. The underlying material to a depth of 84 inches or more is light yellowish brown and yellowish brown, stratified sandy clay loam and clay loam that have thin layers of finer and coarser material. In some areas the surface layer is clay loam. In other areas the soil is reddish brown.

Included in mapping are small areas of Ives soils on flood plains. Also included are soils that are similar to Polacca and Wepo soils on alluvial fans. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is moderately slow in the Jocity soil. Available water capacity is high. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe. This soil is subject to occasional, very brief periods of shallow flooding during high-intensity storms in early spring and summer. The sodium adsorption ratio is less than 5 in the lower part of the soil.

This unit is used for grazing. It is well suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It is moderately suited to the production of riparian shrubs, trees, vines, and herbaceous plants. A few areas are used for dryland farming. This unit can be used as irrigated cropland if water becomes available.

The potential plant community is mainly alkali sacaton, galleta, bottlebrush squirreltail, fourwing saltbush, and winterfat. If the range is improperly used, galleta, winterfat, and mound saltbush increase. If the vegetation is allowed to deteriorate further, black greasewood, Russian-thistle, cheatgrass, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing. This soil is suited to the construction of livestock water impoundments.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation and the hazard of erosion following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. The risk of flooding can be reduced by using dikes and diversions. Basin, graded furrow, graded border, sprinkler, or drip irrigation systems are suitable on this soil. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Water should be added in sufficient quantity to leach the root zone and prevent sodium buildup. Soil blowing can be controlled by stripcropping with narrow strips planted at right angles to the prevailing wind and by maintaining crop residue on the surface.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Clay Fan, 6- to 10-inch precipitation zone.

12—Jocity clay loam, 0 to 2 percent slopes. This deep, well drained, stratified soil is on flood plains. It formed in mixed alluvium derived dominantly from shale and sandstone. Elevation is 4,900 to 5,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is light yellowish brown clay loam about 12 inches thick. The underlying material to a depth of 84 inches or more is light yellowish brown, stratified sandy clay loam, clay loam, and very fine sandy loam. In some areas the surface layer is fine sandy loam.

Included in mapping are small areas of Ives soils and soils that are similar to Polacca soils on flood plains. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is moderately slow in the Jocity soil. Available water capacity is high. Potential rooting depth is 60 inches or more. The hazard of soil blowing is slight. This soil is subject to frequent, brief periods of flooding during high-intensity storms in early spring and summer. Channeling and deposition are common along streambanks. The sodium adsorption ratio is less than 5 in the subsoil.

This unit is used for grazing. It is well suited to the production of wild herbaceous plants, shrubs, and riparian plants for wildlife habitat. It can be used as irrigated cropland if water becomes available.

The potential plant community is mainly western wheatgrass, alkali sacaton, Indian ricegrass, galleta, and fourwing saltbush. Most areas are presently barren. If the range is improperly used, galleta, bottlebrush squirreltail, broom snakeweed, and rubber rabbitbrush

increase. If the vegetation is allowed to deteriorate further, foxtail barley, Russian-thistle, mustard, annual sunflower, and saltcedar invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing. This soil is suited to the construction of livestock water impoundments.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation, crusting and compaction of the soil, and the hazard of erosion following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

Riparian plants, such as cottonwood, willow, ash, walnut, and Russian-olive, grow well on this soil. These types of vegetation provide habitat for a large number of wildlife species, such as quail, woodpeckers, sparrow hawks, cottontail rabbits, owls, mule deer, and antelope. Predators, such as red-tailed hawks, eagles, coyotes, badgers, and skunks, use areas of this unit for hunting. Riparian vegetation should be replanted in drainageways where the soil is moist. Protection from grazing is essential. Competition between cattle and wildlife is high year round.

If this soil is used as cropland, the main management concern is flooding. The risk of flooding can be reduced by using dams and dikes. Tilling when the soil is wet reduces tilth and destroys soil structure, which results in excessive runoff and increased erosion. Irrigation is needed for maximum crop production. If furrow or border systems are used, runs should be on the contour or across the slope. Applying water at a slow rate over a long period helps to ensure that the root zone is properly wetted.

The capability subclass is IVw, irrigated, and VIIw, nonirrigated. The range site is Loamy Bottom, 6- to 10-inch precipitation zone.

13—Jocity clay loam, sodic, 0 to 2 percent slopes. This deep, well drained, stratified soil is on alluvial fans. It formed in mixed alluvium derived dominantly from shale and sandstone. Elevation is 4,800 to 5,200 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is reddish brown clay loam about 1 inch thick. The upper 23 inches of the underlying material is stratified, reddish brown clay loam and sandy clay loam. The lower part to a depth of 84 inches or more is stratified reddish brown, very pale brown, and yellowish brown clay and clay loam. In some areas the surface layer is very fine sandy loam or sandy clay loam.

Included in mapping are small areas of Ives soils on flood plains, Joraibi soils on alluvial fans, and sodic soils that are similar to Naha soils on alluvial fans. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is slow in the Jocity soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is slight. This soil is subject to occasional, very brief periods of shallow flooding in early spring and summer. The sodium adsorption ratio ranges from 20 to 35.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It can be used as irrigated cropland if water becomes available and the soil is reclaimed.

The potential plant community is mainly alkali sacaton, galleta, western wheatgrass, mound saltbush, and black greasewood. Most areas are presently barren. If the range is improperly used, black greasewood, mound saltbush, and Torrey seepweed increase. If the vegetation is allowed to deteriorate further, annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Range recovery is slow because the soil is sodic. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation, the sodium content,

crusting, and soil compaction during and following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Plants that tolerate salt should be seeded. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. The risk of flooding can be reduced by using dikes and diversions. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Because of the slow permeability, the application of water should be carefully regulated so that water does not stand on the surface and damage the crops. Practices that help to reclaim the soil include applying gypsum and adequately leaching the salts from the soil. Salt-tolerant crops can be grown while the soil is being reclaimed. Delaying fieldwork during wet periods helps to prevent soil compaction and subsequent root damage.

The capability subclass is IVs, irrigated, and VIIs, nonirrigated. The range site is Saline Bottom, 6- to 10-inch precipitation zone.

14—Joraibi clay loam, 0 to 2 percent slopes. This deep, well drained, stratified, sodic soil is on alluvial fans. It formed in mixed alluvium derived dominantly from shale and sandstone. Elevation is 4,800 to 4,900 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is reddish brown clay loam about 2 inches thick. The upper 17 inches of the underlying material is reddish brown, yellowish red, and light reddish brown clay loam and sandy clay loam. The next 4 inches is reddish brown very fine sandy loam. The lower part, to a depth of 54 inches, is yellowish red and reddish yellow sand that has thin strata of finer and coarser material. Below this to a depth of 84 inches or more is light reddish brown, stratified very fine sandy loam to clay loam. In some areas the surface is gravelly.

Included in mapping are small areas of Ives soils and sodic Jocity soils on flood plains. Also included, on alluvial fans, are soils that are similar to the Joraibi soil but have a substratum of sandy loam. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is slow in the upper part of the Joraibi soil and moderately rapid in the lower part. Available water capacity is moderate. Potential rooting depth is more than 60 inches, but the penetration of roots is difficult in the contrasting sandy layer. The hazard of soil blowing is slight. This soil is subject to occasional, very brief periods of shallow flooding in early spring and summer. The sodium adsorption ratio ranges from 20 to 40.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It can be used as irrigated cropland if water becomes available and the soil is reclaimed.

The potential plant community is mainly alkali sacaton, galleta, western wheatgrass, mound saltbush, and black greasewood. Most areas are presently barren. If the range is improperly used, black greasewood, mound saltbush, and Torrey seepweed increase. If the vegetation is allowed to deteriorate further, annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Range recovery is slow because the soil is saline and sodic. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation, the sodium content, the content of toxic salts, crusting, and soil compaction during and following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Plants that tolerate salt should be seeded. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. The risk of flooding can be reduced by using dikes and diversions. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. A basin irrigation system works well in the more level areas. Practices that help to reclaim the soil include applying gypsum and adequately leaching the salts and sodium from the root zone. Salt-tolerant crops can be grown while the soil is being reclaimed. The careful application of

irrigation water helps to prevent the formation of a perched water table and increased salt concentration. Tilling when the soil is wet can cause compaction and subsequent root damage. Land leveling that involves only shallow cuts helps to prevent exposing the sandy material.

The capability subclass is IVs, irrigated, and VIIs, nonirrigated. The range site is Saline Bottom, 6- to 10-inch precipitation zone.

15—Kinan complex, 2 to 12 percent slopes. This map unit is on fan terraces skirting basalt-capped buttes and mesas. Elevation is 5,500 to 5,900 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit is 60 percent Kinan very gravelly loamy fine sand and 25 percent Kinan fine sandy loam. The two soils are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in mapping are small areas of Monue and Nakai soils on fan terraces and Sheppard soils on dunes. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Kinan very gravelly loamy fine sand is deep and somewhat excessively drained. It formed in eolian deposits and alluvium derived dominantly from sedimentary rock. Typically, the surface layer is brown very gravelly loamy fine sand about 1 inch thick. The upper 29 inches of the subsoil is brown and light brown fine sandy loam and gravelly fine sandy loam. The lower part to a depth of 84 inches or more is pinkish gray and light brown gravelly fine sand and sand. Gravel lenses in the soil are discontinuous and highly variable. In some areas the surface is cobbly, very cobbly, or extremely gravelly. The content of rock fragments on the surface commonly ranges from 35 to 50 percent. The fragments are dominantly basalt.

Permeability is moderately rapid in this Kinan soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is slight.

Kinan fine sandy loam is deep and somewhat excessively drained. It formed in eolian deposits and alluvium derived dominantly from sedimentary rocks. Typically, the surface layer is light brown fine sandy loam about 2 inches thick. The upper 21 inches of the subsoil is light brown and pinkish gray fine sandy loam that contains 5 percent basalt pebbles. The lower part, to a depth of 65 inches, is pinkish gray gravelly very fine sandy loam, very cobbly very fine sandy loam, and very gravelly fine sandy loam. Below this to a depth of 84 inches or more is pinkish gray and light brown gravelly fine sand and sand. The content of rock fragments on the surface ranges from 0 to 14 percent.

Permeability is moderately rapid in this Kinan soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe.

This unit is used for grazing. The gravelly surface and rough terrain make cultivation impractical.

The potential plant community is mainly Indian ricegrass, black grama, blue grama, galleta, Cutler Mormon tea, and Greene rabbitbrush. If the range is improperly used, galleta, Greene rabbitbrush, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, cheatgrass and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing. Seeding generally is not practical in the areas of very gravelly loamy fine sand because of rough terrain, the content of rock fragments on the surface, and low precipitation.

If the range vegetation is seriously deteriorated, seeding helps recovery in areas of Kinan fine sandy loam. The main limitations affecting range seeding are low precipitation, the slope, and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

This unit is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. Areas of this unit are used by rangeland wildlife, such as antelope and coyote.

The capability subclass is VIIe. The range site is Sandy Loam Upland, 6- to 10-inch precipitation zone.

16—Kydestea-Zyme-Tonalea complex, 5 to 50 percent slopes. This map unit is on hills and dunes. Elevation is 5,900 to 6,800 feet. The mean annual precipitation generally ranges from 10 to more than 14 inches, but in a few areas it is less than 12 inches. The mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

This unit is 45 percent Kydestea very channery sandy clay loam, 5 to 50 percent slopes; 25 percent Zyme clay loam, 5 to 50 percent slopes; and 20 percent Tonalea loamy fine sand, 5 to 20 percent slopes. The three soils are so intermingled that it was not practical to map them separately at the scale used.

Included in mapping are small areas of soils that are similar to Begay soils on plateaus, Mido soils on dunes, Penistaja and Travessilla soils on plateaus, and moderately deep, loamy soils on ridges and hilltops and along the edges of the mapped areas. Also included are small areas of rock outcrop. Included areas make up about 10 percent of the unit. The percentage varies from one area to another.

The Kydestea soil is very shallow and shallow and is well drained. It formed in alluvium and colluvium derived dominantly from sedimentary rocks. Typically, the surface layer is light yellowish brown very channery sandy clay loam about 1 inch thick. The underlying material, to a depth of 15 inches, is brown and pale brown very channery sandy clay loam and extremely channery sandy clay loam. Fractured sandstone is at a depth of about 15 inches. The depth to sandstone ranges from 4 to 19 inches. In some areas the surface layer is channery clay loam or channery fine sandy loam. In some areas in the extreme northeast part of the survey area, the soil is coarser textured and is reddish brown to yellowish red.

Permeability is moderately slow in the Kydestea soil. Available water capacity is very low. Potential rooting depth is 4 to 19 inches. The hazard of soil blowing is slight.

The Zyme soil is very shallow and shallow and is well drained. It formed in alluvium and residuum derived dominantly from shale. Typically, the surface layer is yellowish brown clay loam about 1 inch thick. The upper 3 inches of the underlying material is yellowish brown clay. The lower part, to a depth of 18 inches, is brown clay. Shale is at depth of 18 inches. The depth to shale ranges from 6 to 20 inches. In some areas the surface layer is silty clay loam or fine sandy loam.

Permeability is slow in the Zyme soil. Available water capacity is very low. Potential rooting depth is 6 to 20 inches. The hazard of soil blowing is slight.

The Tonalea soil is moderately deep and is excessively drained. It formed in eolian deposits derived dominantly from sandstone. The eolian deposits occur in the less sloping areas. Typically, the surface layer is brown loamy fine sand about 3 inches thick. The underlying material, to a depth of 24 inches, is brown loamy fine sand. Weathered sandstone is at a depth of about 24 inches. Hard sandstone is at a depth of about 26 inches. The depth to sandstone ranges from 20 to 39 inches.

Permeability is rapid in the Tonalea soil. Available water capacity is very low. Potential rooting depth is 20 to 39 inches. The hazard of soil blowing is moderate.

This unit is used for fuel wood or grazing.

The potential plant community on the Kydestea soil is mainly Utah juniper and pinyon pine (25 to 35 percent canopy cover) with an understory of Bigelow sagebrush, Stansbury cliffrose, green Mormon tea, Indian ricegrass, galleta, and bottlebrush squirreltail. If the range is improperly used, Utah juniper, pinyon pine, Bigelow sagebrush, Stansbury cliffrose, and thrifty goldenweed increase.

The potential plant community on the Zyme soil is mainly galleta, alkali sacaton, bottlebrush squirreltail, and shadscale. If the range is improperly used, galleta, golden buckwheat, Greene rabbitbrush, and shadscale increase.

The potential plant community on the Tonalea soil is mainly Utah juniper and pinyon pine (25 to 35 percent canopy cover) with an understory of Indian ricegrass, blue grama, needleandthread, galleta, Stansbury cliffrose, and Wyoming big sagebrush. If the range is improperly used, Wyoming big sagebrush, Stansbury cliffrose, Utah juniper, and pinyon pine increase.

The Kydestea and Tonalea soils are well suited to the production of Utah juniper and pinyon pine for use as fuel wood, fence posts, and Christmas trees. The Kydestea soil can produce about 2 to 4 cords per acre, and the Tonalea soil can produce about 3 to 5 cords per acre in stands of trees that average 5 inches in diameter at a height of 1 foot. Production of understory vegetation averages about 300 pounds per acre for the Kydestea soil and about 500 pounds per acre for the Tonalea soil. Thinning dense stands of trees increases the production of understory forage plants. Management measures that minimize the hazard of erosion are needed when fuel wood and wood for fence posts are harvested.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing. Seeding generally is not practical on the Kydestea and Zyme soils because of the very low available water capacity, the slope, and rough terrain. Disturbed areas of the Tonalea soil can be protected against erosion by seeding adapted plants. Chaining is not practical on any of these soils. The slope limits

access by livestock and results in overgrazing in the less sloping areas.

The Kydestea and Tonalea soils are well suited to the production of coniferous trees for wildlife habitat. They are moderately suited to the production of wild herbaceous plants and shrubs. The pinyon-juniper woodlands provide habitat for many species, such as bear, coyote, bluejay, bluebird, eagle, badger, skunk, mule deer, antelope, hawk, owl, turkey, and ravens.

The Zyme soil is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It is poorly suited to the production of coniferous trees.

The capability subclass is VIs. The woodland site of the Kydestea soil is Sandstone Hills (J-P), 10- to 14-inch precipitation zone. The range site of the Zyme soil is Clayey Slopes, 10- to 14-inch precipitation zone. The woodland site of the Tonalea soil is Sandy Upland (J-P), 10- to 14-inch precipitation zone.

17—Mido fine sand, 1 to 15 percent slopes. This deep, excessively drained soil is on dunes. It formed in eolian deposits derived dominantly from sandstone. Elevation is 5,800 to 6,600 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

Typically, the surface layer is brown fine sand about 3 inches thick. The underlying material to a depth of 84 inches or more is strong brown fine sand. In most areas the surface layer is noneffervescent. In a few areas the surface layer is effervescent.

Included in mapping are small areas of Begay soils on plateaus adjacent to dunes, Milok soils on ridges on plateaus, Penistaja soils in swales on plateaus, and Tonalea soils on dunes. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is rapid in the Mido soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It is poorly suited to the production of coniferous trees. A few areas are used for dryland farming. This unit can be used as irrigated cropland if water becomes available.

The potential plant community is mainly needleandthread, Indian ricegrass, blue grama, sand sagebrush, Cutler Mormon tea, scattered Utah juniper, and pinyon pine. If the range is improperly used, sandhill muhly, sand sagebrush, thinstem buckwheat, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

Proper grazing practices are essential. Overgrazing seriously increases the hazard of erosion. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating salt and livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are the slope and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Because of the slope and a high intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. A sprinkler irrigation system does not work well in the steeper areas. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Leaving crop residue on or near the surface conserves moisture, maintains tilth, and helps to control erosion. Soil blowing can be controlled by planting crops in alternate strips at right angles to the prevailing wind. A crop rotation that includes a close-growing, high-residue crop helps to control soil blowing and improves soil tilth. Keeping the surface moist during the spring also reduces the hazard of soil blowing.

The capability subclass is IIIe, irrigated, and VIe, nonirrigated. The range site is Sandy Upland, 10- to 14-inch precipitation zone.

18—Mido-Begay complex, 1 to 8 percent slopes. This map unit is on plateaus. Elevation is 5,800 to 6,600 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 130 to 150 days.

This unit is 50 percent Mido loamy fine sand and 35 percent Begay loamy sand. The two soils occur as areas so intermingled that it was not practical to map

them separately at the scale used. The Mido soil is on long dunes, and the Begay soil is between the dunes.

Included in mapping are small areas of Bighams soils on ridges on plateaus and hills and Penistaja soils in swales on plateaus. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

The Mido soil is deep and excessively drained. It formed in eolian sand derived dominantly from sandstone. Typically, the surface layer is brown loamy fine sand about 3 inches thick. The underlying material to a depth of 84 inches or more is brown loamy fine sand and fine sand. In most areas the surface layer is noneffervescent. In some areas the surface layer is loamy sand or sand and is effervescent.

Permeability is rapid in the Mido soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

The Begay soil is deep and well drained. It formed in eolian deposits derived dominantly from sandstone. Typically, the surface layer is light brown loamy sand about 1 inch thick. The upper 13 inches of the underlying material is light brown loamy sand and sand. The lower part to a depth of 84 inches or more is light brown fine sandy loam and loamy fine sand. In some areas the surface layer is fine sandy loam.

Permeability is moderately rapid in the Begay soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat, but it is poorly suited to the production of coniferous trees. These soils can be used as irrigated cropland if water becomes available.

The potential plant community on the Mido soil is mainly needleandthread, Indian ricegrass, blue grama, bottlebrush squirreltail, Cutler Mormon tea, sand sagebrush, and scattered Utah juniper and pinyon pine. If the range is improperly used, sandhill muhly, sand sagebrush, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

The potential plant community on the Begay soil is mainly Indian ricegrass, needleandthread, blue grama, bottlebrush squirreltail, Cutler Mormon tea, Wyoming big sagebrush, and scattered Utah juniper and pinyon pine. If the range is improperly used, galleta, bottlebrush squirreltail, broom snakeweed, Wyoming big sagebrush, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, and annual forbs invade.

Proper grazing practices are essential. If these soils are overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are looseness of the soil and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings. A weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established. Brush management improves deteriorated areas of range that are producing more woody shrubs than were in the potential plant community.

If this unit is used as cropland, irrigation is needed for maximum production. Because of the slope and the intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Leaving crop residue on or near the surface conserves moisture, maintains tilth, and helps to control erosion. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind, maintaining crop residue on the surface, and using a cropping system that includes a close-growing, high-residue crop in the rotation. Keeping the surface moist during the spring also helps to control soil blowing.

The capability subclass is IIIe, irrigated, and VIe, nonirrigated. The range site of the Mido soil is Sandy Upland, 10- to 14-inch precipitation zone, and that of the Begay soil is Sandy Loam Upland, 10- to 14-inch precipitation zone.

19—Milok-Mido complex, 1 to 12 percent slopes. This map unit is on plateaus. Elevation is 6,000 to 6,600 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

This unit is 50 percent Milok fine sandy loam and 35

percent Mido loamy fine sand. The two soils occur as areas so intermingled that it was not practical to map them separately at the scale used. The Milok soil is between dunes, and the Mido soil is on the dunes.

Included in mapping are small areas of soils that are similar to the Milok soil but are moderately deep or shallow. These soils are near mesa edges and ridges. Also included are soils that are similar to the Milok soil but have cobbles in the solum and small areas that are more sloping than the major soils. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

The Milok soil is deep and well drained. It formed in eolian deposits over alluvium derived dominantly from sandstone and limestone. Typically, the surface layer is strong brown fine sandy loam about 2 inches thick. The upper 13 inches of the subsoil is dominantly strong brown, brown, and light brown very fine sandy loam and gravelly very fine sandy loam. The lower part, to a depth of 35 inches, is pinkish white sandy loam. The substratum, to a depth of 55 inches, is banded white and pinkish white fine sand. Soft sandstone is at a depth of 55 inches. The depth to soft sandstone ranges from 40 to 60 inches. In some areas the surface layer is loamy sand.

Permeability is moderately rapid in the Milok soil. Available water capacity is moderate. Potential rooting depth is 40 to 60 inches. The hazard of soil blowing is severe. The content of lime ranges from 15 to 40 percent in the lower part of the subsoil.

The Mido soil is deep and excessively drained. It formed in eolian deposits derived dominantly from sandstone. Typically, the surface layer is reddish brown loamy fine sand about 2 inches thick. The upper 55 inches of the underlying material is reddish brown loamy sand and fine sand. The lower part to a depth of 84 inches or more is variegated pinkish white, strong brown, light brown, and reddish yellow loamy sand and gravelly loamy sand. In most areas the surface layer is noneffervescent. In some areas the surface layer is fine sand and is effervescent.

Permeability is rapid in the Mido soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat, but it is poorly suited to the production of coniferous trees. These soils can be used as irrigated cropland if water becomes available.

The potential plant community on the Milok soil is mainly needleandthread, blue grama, Indian ricegrass, galleta, Wyoming big sagebrush, and scattered Utah juniper and pinyon pine. If the range is improperly used, galleta, blue grama, Fendler threeawn, gray horsebrush, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass and annual forbs invade.

The potential plant community on the Mido soil is mainly needleandthread, Indian ricegrass, blue grama, sand sagebrush, Cutler Mormon tea, and scattered Utah juniper and pinyon pine. If the range is improperly used, sandhill muhly, sand sagebrush, thinstem buckwheat, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

Proper grazing practices are essential. If these soils are overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are looseness of the soil and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings. A weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established. Brush management improves deteriorated areas of range that are producing more woody shrubs than were in the potential plant community.

If these soils are used as cropland, irrigation is needed for maximum production. Because of the slope and the intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind and by maintaining crop residue on the surface. A cropping system that includes a close-growing, high-residue crop in the rotation helps to control soil blowing and improves soil tilth and the content of organic matter. Lime in the subsoil of the Milok soil causes chlorosis in

some plants. Chlorosis can be prevented by applying soil amendments or plant sprays.

The capability subclass is IIIe, irrigated, and VIe, nonirrigated. The range site of the Milok soil is Sandy Loam Upland, 10- to 14-inch precipitation zone, and that of the Mido soil is Sandy Upland, 10- to 14-inch precipitation zone.

20—Monue very fine sandy loam, 1 to 5 percent slopes. This deep, well drained soil is on plateaus. It formed in loamy eolian deposits. Elevation is 5,600 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is reddish brown very fine sandy loam about 1 inch thick. The upper 45 inches of the subsoil is dominantly reddish brown, strong brown, and pink fine sandy loam. The lower part to a depth of 84 inches or more is very pale brown loamy fine sand. In some areas the surface layer is loamy sand. In other areas loamy sand is at a depth of 30 to 40 inches. In places the sodium adsorption ratio is as high as 10 below a depth of 40 inches.

Included in mapping are small areas of Jeddito soils on stream terraces, Nakai soils on fan terraces, Tewa soils in swales on stream terraces, and Sheppard soils on dunes. Included areas make up about 10 percent of the unit. The percentage varies from one area to another.

Permeability is moderately rapid in the Monue soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe.

This unit is used for grazing. A few areas are used for dryland farming. This soil can be used for irrigated crops if water becomes available.

The potential plant community is mainly Indian ricegrass, blue grama, galleta, needleandthread, Cutler Mormon tea, and fourwing saltbush. If the range is improperly used, galleta, Fendler threeawn, Cutler Mormon tea, broom snakeweed, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this unit. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

This soil is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat.

If this soil is used as cropland, irrigation is needed for maximum production. Because of the slope and the intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind and by maintaining crop residue on the surface. Field windbreaks and minimum tillage also help to control soil blowing.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Sandy Loam Upland, 6- to 10-inch precipitation zone.

21—Naha loamy sand, 0 to 3 percent slopes. This deep, well drained soil is on stream terraces. It formed in moderately thick sandy alluvium over stratified loamy alluvium derived dominantly from sandstone and shale. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is light yellowish brown loamy sand about 2 inches thick. The upper 25 inches of the underlying material is light yellowish brown loamy fine sand and yellowish brown loamy sand. The next 31 inches is stratified pale brown and dark grayish brown loamy sand, loamy very fine sand, very fine sandy loam, silty clay loam, and clay. The lower part to a depth of 84 inches or more is light yellowish brown sandy loam. In some areas the surface layer is sand.

Included in mapping are small areas of Ives and Jocity soils on flood plains along small intermittent drainageways and Jeddito and Wepo soils on stream terraces. Also included, in the extreme southwest part of the survey area, are a few small areas of Naha soils that have a moderate content of sodium. Included areas

make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is rapid in the upper 27 inches of the Naha soil and slow in the lower part. Available water capacity is moderate. Potential rooting depth is 60 inches or more, but the penetration of roots is restricted by the loamy layer. The hazard of soil blowing is very severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It is poorly suited to the production of riparian shrubs, trees, vines, and herbaceous plants. A few areas are used for dryland farming. This soil can be used as irrigated cropland if water becomes available.

The potential plant community is mainly Indian ricegrass, galleta, blue grama, bottlebrush squirreltail, fourwing saltbush, and winterfat. If the range is improperly used, galleta, Fendler threeawn, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, Russian-thistle, and other annual forbs invade.

Proper grazing practices are essential. If this soil is overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation.

If this soil is used as cropland, irrigation is needed for maximum production. Graded furrow, graded border, drip, and sprinkler irrigation systems work well on this soil. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. A sprinkler irrigation system works well in the more sloping areas. If furrow irrigation is used, the water should be applied at frequent intervals and runs should be short because of a high intake rate. Careful applications of irrigation water help to prevent the formation of a perched water table and increased salt concentrations. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind, maintaining crop residue on the surface, and using a crop rotation that includes a close-growing cover crop. Keeping the surface moist during the spring also helps to control soil blowing. Leaving crop residue on or near the surface conserves moisture, maintains tilth, and helps to control erosion.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Sandy Terrace, 6- to 10-inch precipitation zone.

22—Nakai fine sandy loam, 3 to 15 percent slopes. This deep, well drained soil is on fan terraces. It formed in eolian deposits over alluvium derived dominantly from sandstone and shale. Elevation is 5,500 to 5,800 feet. The mean annual precipitation is 7 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is brown fine sandy loam about 2 inches thick. The upper 4 inches of the subsoil is brown fine sandy loam. The next 8 inches is yellowish red fine sandy loam. The lower part, to a depth of 41 inches, is variegated reddish yellow, very pale brown, and white fine sandy loam. Partially weathered sandstone is at a depth of about 41 inches. The depth to partially weathered sandstone ranges from 40 to 60 inches. In some areas the sandstone is below a depth of 60 inches. In other areas a layer of white, weakly lime-cemented sand 6 to 12 inches thick is above the sandstone.

Included in mapping are small areas of Monue soils on fan terraces adjacent to dunes and Sheppard soils on dunes. Also included, in the steeper areas, are soils that are similar to the Nakai soil but are shallow or moderately deep. Included areas make up about 10 percent of the unit. The percentage varies from one area to another.

Permeability is moderately rapid in the Nakai soil. Available water capacity is moderate. Potential rooting depth is 40 to 60 inches. The hazard of soil blowing is severe. The content of calcium carbonate is more than 15 percent below a depth of 20 inches.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It can be used as irrigated cropland if water becomes available.

The potential plant community is mainly Indian ricegrass, galleta, blue grama, bottlebrush squirreltail, Cutler Mormon tea, winterfat, and fourwing saltbush. If the range is improperly used, galleta, ring muhly, Cutler

Mormon tea, broom snakeweed, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation, the slope, and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Because of the slope, sprinkler or drip irrigation systems are the most suitable for row crops. Sprinkler irrigation systems are not practical in the steeper areas. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Maintaining crop residue on or near the surface helps to control runoff and soil blowing and maintains soil tilth and the content of organic matter. Lime in the subsoil causes chlorosis in some plants. Chlorosis can be prevented by applying soil amendments or plant sprays.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Sandy Loam Upland, 6- to 10-inch precipitation zone.

23—Nakai-Monue very fine sandy loams, 1 to 5 percent slopes. This map unit is on plateaus (fig. 6). Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit is 45 percent Nakai soil and 40 percent Monue soil. The two soils occur as areas so intricately intermingled that it was not practical to map them separately at the scale used.

Included in mapping are small areas of Sheppard soils on dunes and Tewa soils in swales on stream terraces. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

The Nakai soil is deep and well drained. It formed in eolian deposits over alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish red very fine sandy loam about 3 inches thick. The upper part of the subsoil is dominantly yellowish red and brown fine sandy loam and very fine sandy loam about 27 inches thick. The lower part to a depth of 84 inches or more is light brown and pinkish white sandy clay loam. In some areas the surface layer is fine sandy loam. In places the sodium adsorption ratio is more than 15 below a depth of 40 inches.

Permeability is moderate in the Nakai soil. Available water capacity also is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe. The content of calcium carbonate is more than 15 percent below a depth of 20 inches.

The Monue soil is deep and well drained. It formed in loamy eolian deposits. Typically, the surface layer is yellowish red very fine sandy loam about 2 inches thick. The subsoil extends to a depth of 84 inches or more. It is dominantly yellowish red and light brown fine sandy loam and very fine sandy loam. In some areas the surface layer is fine sandy loam or loamy fine sand. In places the sodium adsorption ratio is more than 15 below a depth of 40 inches.

Permeability is moderately rapid in the Monue soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. A few small areas are used for dryland farming. These soils can be used as irrigated cropland if water becomes available.

The potential plant community is mainly Indian ricegrass, galleta, blue grama, bottlebrush squirreltail, needleandthread, Cutler Mormon tea, winterfat, and fourwing saltbush. If the range is improperly used, galleta, Fendler threeawn, Cutler Mormon tea, broom snakeweed, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock

Figure 6.—An area of Nakai-Monue very fine sandy loams, 1 to 5 percent slopes, is in the foreground. Strych-Rock outcrop complex, 25 to 60 percent slopes, is on the butte in the background.

watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If these soils are used as cropland, irrigation is needed for maximum production. Basin, graded furrow, graded border, drip, or sprinkler irrigation systems work well. Because of the slope, sprinkler or drip irrigation systems are the most suitable for row crops. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind and by maintaining crop residue on the surface. Field windbreaks and minimum tillage also help to control soil blowing. Lime in the subsoil of the Nakai soil causes chlorosis in some plants. Chlorosis can be prevented by applying soil amendments or plant sprays.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Sandy Loam Upland, 6- to 10-inch precipitation zone.

24—Penistaja-Begay complex, 1 to 8 percent slopes. This map unit is on plateaus. Elevation is 5,900 to 6,800 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

This unit is 45 percent Penistaja fine sandy loam and 40 percent Begay very fine sandy loam. The two soils occur as areas so intricately intermingled that it was not practical to map them separately at the scale used.

Included in mapping are small areas of Hano soils on pediments, Mido soils on dunes, Milok soils on ridges on plateaus, Querencia soils in swales on stream terraces, and Travessilla soils and moderately deep, loamy soils on plateaus and mesa edges. Also included are a few areas that have slightly higher levels of precipitation. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

The Penistaja soil is deep and well drained. It formed in eolian deposits and alluvium derived dominantly from sandstone. Typically, the surface layer is brown fine sandy loam about 2 inches thick. The upper 16 inches of the subsoil is yellowish red and brown sandy clay loam. The next 40 inches is brown fine sandy loam and loam. The lower part to a depth of 84 inches or more is light yellowish brown gravelly loamy sand. In some areas the surface layer is loamy fine sand, very fine sandy loam, or clay loam.

Permeability is moderate in the Penistaja soil. Available water capacity is high. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe. The sodium adsorption ratio is as high as 5 below a depth of 40 inches.

The Begay soil is deep and well drained. It formed in eolian deposits derived dominantly from sandstone. Typically, the surface layer is brown and yellowish red very fine sandy loam about 4 inches thick. The upper 53 inches of the subsoil is dominantly brown and strong brown fine sandy loam and very fine sandy loam. The lower part to a depth of 84 inches or more is reddish yellow loamy fine sand. In some places the surface layer is fine sandy loam.

Permeability is moderately rapid in the Begay soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe. The sodium adsorption ratio is as high as 12 below a depth of 40 inches.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants, shrubs, and vines for wildlife habitat, but it is poorly suited to the production of coniferous trees. These soils can be used as irrigated cropland if water becomes available.

The potential plant community is mainly needleandthread, blue grama, Indian ricegrass, galleta, Cutler Mormon tea, Wyoming big sagebrush, and scattered Utah juniper and pinyon pine. If the range is improperly used, galleta, Fendler threeawn, Wyoming big sagebrush, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are looseness of the soil and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established. Brush management improves deteriorated areas of range that are producing more woody shrubs than were in the potential plant community. Seeding and brush management have been successful in areas of these soils (fig. 7).

If this unit is used as cropland, irrigation is needed for maximum production. Basin, graded border, graded furrow, drip, or sprinkler irrigation systems work well on this unit. Because of the slope, sprinkler or drip irrigation systems are the most suitable for row crops. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind and by maintaining crop residue on the surface. Field windbreaks and minimum tillage also help to control soil blowing.

The capability subclass is IIIe, irrigated, and VIe, nonirrigated. The range site is Sandy Loam Upland, 10- to 14-inch precipitation zone.

25—Polacca clay loam, 0 to 3 percent slopes. This deep, well drained soil is on stream terraces. It formed in alluvium derived dominantly from sandstone and

Figure 7.—Rangeland in an area of Penistaja-Begay complex, 1 to 8 percent slopes. Range can be improved by controlling the growth of shrubs and by reseeding. Only the area to the right of the fence has been seeded.

shale. Elevation is 5,100 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is pale brown clay loam about 3 inches thick. Below this is 30 inches of stratified yellowish brown and light yellowish brown very fine sandy loam to clay. The substratum to a depth of 84 inches or more is light yellowish brown loamy sand that has few thin strata of very fine sandy loam. In some areas the surface layer is fine sandy loam or sandy clay loam. In other areas the soil has more clay in the subsoil and a slight amount of sodium.

Included in mapping are small areas of Ives and Jocity soils on flood plains and Uzona and Wepo soils on low stream terraces. Also included are soils that are similar to Monue soils but have a deposition of clay loam on the surface. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is slow in the upper 33 inches of the Polacca soil and rapid below this depth. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is slight. This soil is subject to rare, very brief periods of flooding during high-intensity storms in early spring and summer.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It is poorly suited to the production of riparian shrubs, trees, vines, and herbaceous plants. A few small areas are used for dryland farming. This soil can be used as irrigated cropland if water becomes available.

The potential plant community is mainly alkali sacaton, galleta, western wheatgrass, bottlebrush squirreltail, winterfat, and fourwing saltbush. If the range is improperly used, galleta, mound saltbush, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, black greasewood, Torrey

seepweed, cheatgrass, Russian-thistle, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation, crusting and compaction of the soil, and the hazard of erosion following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential if seedlings are to be established on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Basin, graded furrow, graded border, and drip irrigation systems work well. The sandy substratum at a depth of about 33 inches restricts the growth of deep-rooted crops. Applying water at a slow rate over a long period helps to ensure that the root zone is properly wetted. Because of the slow permeability, the length of runs should be adjusted to permit adequate infiltration of water. Careful applications of irrigation water help to prevent the formation of a perched water table and increased salt concentrations. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases the water intake rate. The risk of flooding can be reduced by using dikes and diversions. Tilling when the soil is wet reduces soil tilth and destroys structure, which results in root damage, excessive runoff, and increased erosion.

The capability subclass is IIs, irrigated, and VIIs, nonirrigated. The range site is Clay Fan, 6- to 10-inch precipitation zone.

26—Querencia clay loam, 0 to 3 percent slopes. This deep, well drained soil is on stream terraces. It formed in mixed alluvium derived dominantly from sandstone and shale. Elevation is 6,200 to 6,500 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

Typically, the surface layer is pale brown clay loam about 1 inch thick. The upper 32 inches of the subsoil is dominantly light yellowish brown sandy clay loam and clay loam. The lower part to a depth of 84 inches or more is pale brown and yellowish brown fine sandy loam and loam. In some areas the surface layer is fine sandy loam.

Included in mapping are small areas of loamy soils that have a sandy substratum and clayey over loamy soils on stream terraces. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is moderate in the Querencia soil. Available water capacity is high. Potential rooting depth is 60 inches or more. The hazard of soil blowing is slight. This soil is subject to rare, very brief periods of flooding from overland flow during high-intensity storms in early spring and summer.

This unit is used for grazing. It can be used as irrigated cropland if water becomes available.

The potential plant community is mainly western wheatgrass, bottlebrush squirreltail, sand dropseed, Indian ricegrass, and fourwing saltbush. If the range is improperly used, western wheatgrass, fourwing saltbush, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, Russian-thistle, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are the hazard of water erosion and soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two seasons or until the plants are well established. This soil is suited to the construction of livestock water impoundments.

If this soil is used as cropland, irrigation is needed for maximum production. Basin, graded furrow, graded border, and drip irrigations systems are suitable. The design of irrigation systems is difficult because of large

gullies. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Maintaining crop residue on or near the surface helps to control runoff and erosion and maintains soil tilth and the content of organic matter. Controlling runoff helps to prevent the formation of gullies. Cultivating when the soil is wet results in compaction, damages roots of plants, and increases runoff and erosion.

This soil is well suited to the production of wild herbaceous plants and shrubs for wildlife habitat. Antelope use areas of this soil for feeding and fawning.

The capability subclass is IIs, irrigated, and VIs, nonirrigated. The range site is Loamy Upland, 10- to 14-inch precipitation zone.

27—Rock outcrop. This map unit consists of large exposures of sandstone. It occurs on escarpments and on hillslopes of geologic folds, predominantly along Begashibito Wash. Elevation is 5,000 to 5,600 feet. Areas of this unit support little or no vegetation.

Included in mapping are small areas of Sheppard soils on dunes, areas of dune land, and areas of shallow or moderately deep, sandy soils. Included areas make up about 5 percent of the unit. The percentage varies from one area to another.

This unit is used as wildlife habitat. It provides very important nesting habitat for eagles, crows, hawks, owls, and swallows. Bats use the cracks and caves for resting. Foxes, bobcats, and cougars use overhangs and cracks in the rock as dens.

No capability subclass or range site is assigned.

28—Rock outcrop-Torriorthents complex, 5 to 60 percent slopes. This map unit is on escarpments and on adjacent hills and canyon walls of mesas and plateaus (fig. 8). Elevation is 5,800 to 6,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit is 50 percent Rock outcrop and 40 percent Torriorthents. The components of this unit occur as areas so intermingled that it was not practical to map them separately at the scale used. Large areas of Rock outcrop occur between areas of the less sloping Torriorthents.

Included in mapping are small areas of Cannonville soils on hills, Mido soils on dunes, and Travessilla soils in nearly level areas on plateaus and mesas. Included areas make up about 10 percent of the unit. The percentage varies from one area to another.

Rock outcrop consists of barren or nearly barren exposures of sandstone and shale. It occurs on steep hills and mesa escarpments.

Torriorthents are very shallow to moderately deep, well drained soils on hills and sides of mesas and plateaus. They formed in local alluvium and colluvium derived dominantly from sandstone and shale. They have a wide range of characteristics. Textures of the surface layer and underlying material include sand, loamy sand, sandy loam, sandy clay loam, clay loam, or sandy clay. The content of rock fragments ranges from 0 to 70 percent.

Permeability is slow to rapid in the Torriorthents. Potential rooting depth is 3 to 40 inches. The hazard of soil blowing is slight to severe.

This unit has limited potential for any use. Some areas are used for grazing. The exposed sandstone erodes into blocks that are used for home construction. Springs are numerous in areas of this unit and have been used by the Indians for centuries. The Rock outcrop supports no vegetation but provides important nesting sites for eagles, crows, hawks, owls, and swallows. Bats use the caves and cracks. Foxes, bobcats, and coyotes use the overhangs and cracks in the rock as dens. Water sources in this unit are vital to local populations of mammals. Birds that inhabit adjacent areas tend to concentrate in areas of this unit. The Torriorthents are poorly suited to the production of wild herbaceous plants, shrubs, and coniferous trees for wildlife habitat. The small quantity of vegetation produced is offset, however, by the variety of types of vegetation, which attracts many species. The steep slopes and broken topography provide safety for wildlife.

The potential plant community on the Torriorthents is mainly Bigelow sagebrush, Stansbury cliffrose, Cutler Mormon tea, Utah juniper, pinyon pine, golden buckwheat, muttongrass, galleta, and Indian ricegrass. If the range is improperly used, Utah juniper, Bigelow sagebrush, galleta, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

This unit can be grazed by a few livestock for a limited time. The unit is actively eroding. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced community that includes a great variety of high-quality forage plants. Seeding generally is not practical on this unit because of the slope, the rough terrain, and stones, cobbles, and gravel on the surface. The slope limits access by livestock and results in overgrazing in the less sloping areas. The numerous springs can be developed for use by livestock and wildlife.

The capability subclass of the Torriorthents is VIIIe.

Figure 8.—An area of Rock outcrop-Torriorthents complex, 5 to 60 percent slopes, is in the background. Tewa very fine sandy loam, 1 to 5 percent slopes, is in the foreground.

The range site is Breaks, 10- to 14-inch precipitation zone. The Rock outcrop is not assigned a capability subclass or range site.

29—Sheppard sand, 1 to 12 percent slopes. This deep, somewhat excessively drained soil is on dunes. It formed in eolian deposits derived dominantly from sandstone. It is adjacent to escarpments of Mesa Verde sandstone. Elevation is 5,600 to 5,900 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the annual frost-free period is 130 to 160 days.

Typically, the surface layer is light yellowish brown sand about 1 inch thick. The upper 48 inches of the underlying material is light yellowish brown sand. The lower part to a depth of 84 inches or more is yellowish brown sand. The soil is noneffervescent throughout. In some areas the surface layer is loamy sand.

Included in mapping are small areas of Cannonville soils on hills and Jeddito soils in swales on stream terraces and fan terraces. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is rapid in the Sheppard soil. Available water capacity is very low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

This unit is used for grazing. It is poorly suited to the production of wild herbaceous plants and shrubs for wildlife habitat. A few small areas are used for dryland farming. This soil can be used as irrigated cropland if water becomes available.

The potential plant community is mainly Indian ricegrass, needleandthread, blue grama, bottlebrush squirreltail, and broom snakeweed. If the range is improperly used, sandhill muhly, Fendler threeawn, broom snakeweed, and hoary rosemarymint increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

Proper grazing practices are essential. If this soil is overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in

pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Because of the slope and the intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by returning crop residue to the soil and by minimizing tillage. A cropping system that includes a close-growing, high-residue crop in the rotation helps to control soil blowing and improves soil tilth and the content of organic matter. Keeping the surface moist during the spring also helps to control soil blowing.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Sandy Upland, 6- to 10-inch precipitation zone.

30—Sheppard sand, sodic, 1 to 8 percent slopes. This deep, somewhat excessively drained soil is on dunes. It formed in eolian deposits derived dominantly from sandstone. Elevation is 4,800 to 5,100 feet. The mean annual precipitation is 6 or 7 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is yellowish red sand about 1 inch thick. The upper 15 inches of the underlying material is yellowish red sand. The lower part to a depth of 84 inches or more is yellowish red fine sand. In some areas the surface layer is fine sand.

Included in this area are small areas of sodic Monue soils on fan terraces and Naha soils on stream terraces and in blown-out areas. Included areas make up about 5 percent of the unit. The percentage varies from one area to another.

Permeability is moderately rapid in the Sheppard soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe. The sodium adsorption ratio ranges from 10 to 15.

This unit is used for grazing. It is poorly suited to the production of wild herbaceous plants and shrubs for wildlife habitat. It can be used as irrigated cropland if water becomes available and the soil is reclaimed.

The potential plant community is mainly alkali sacaton, Indian ricegrass, galleta, sandhill muhly, and fourwing saltbush. If the range is improperly used, alkali sacaton, galleta, sandhill muhly, broom snakeweed, and annual forbs increase.

Proper grazing practices are essential. If this soil is overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation, the content of sodium, and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Plants that tolerate sodium should be selected for seeding. Timely seeding is essential for the establishment of seedlings. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Because of the slope and the intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. Water should be applied in amounts that are small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by returning crop residue to the soil and by minimizing tillage. Establishing field windbreaks and keeping the surface moist during the spring also help to control soil blowing. Practices that help to reclaim the soil include applying gypsum and adequately leaching the sodium from the root zone. Salt-tolerant crops can be grown

while the soil is being reclaimed.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Sandy Upland (Sodic), 6- to 10-inch precipitation zone.

31—Sheppard loamy sand, 1 to 15 percent slopes. This deep, somewhat excessively drained soil is on dunes. It formed in eolian deposits derived dominantly from sandstone. Elevation is 4,800 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is yellowish red loamy sand about 2 inches thick. The underlying material to a depth of 84 inches or more is yellowish red fine sand and loamy fine sand. In some areas the surface layer is fine sand.

Included in mapping are small areas of Jeddito soils on stream terraces, Monue and Nakai soils in interdunal areas on fan terraces and plateaus, and steeper areas of dunes. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is rapid in the Sheppard soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. A few small areas are used for dryland farming. This soil can be used as irrigated cropland if water becomes available.

The potential plant community is mainly Indian ricegrass, needleandthread, blue grama, galleta, Cutler Mormon tea, and sand sagebrush. If the range is improperly used, galleta, sandhill muhly, Fendler threeawn, broom snakeweed, and sand sagebrush increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

Proper grazing practices are essential (figs. 9 and 10). If this soil is overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation, the slope, and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If this soil is used as cropland, irrigation is needed for maximum production. Because of the slope and the intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. Sprinkler irrigation systems are not practical, however, in the steeper areas. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by returning crop residue to the soil and minimizing tillage. A cropping system that includes a close-growing, high-residue crop in the rotation helps to control soil blowing and improves tilth and the content of organic matter. Keeping the soil moist during the spring also helps to control soil blowing.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Sandy Upland, 6- to 10-inch precipitation zone.

32—Sheppard-Monue complex, 1 to 8 percent slopes. This map unit is on plateaus. Elevation is 4,900 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit is 50 percent Sheppard loamy sand and 40 percent Monue fine sandy loam. The two soils occur as areas so closely intermingled that it was not practical to map them separately at the scale used. The Sheppard soil is on dunes, and the Monue soil is between the dunes.

Included in mapping are small areas of Jeddito, Nakai, and Tewa soils in swales on stream terraces and fan terraces. Included areas make up about 10 percent of the unit. The percentage varies from one area to another.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian deposits derived dominantly from sandstone. Typically, the surface layer is yellowish red loamy sand about 2 inches thick. The underlying material to a depth of 84 inches or more is yellowish red loamy sand and fine sand. In some areas the surface layer is fine sand. In some places near the Hopi Buttes, the soil has discontinuous layers of gravel.

Some areas have slopes of more than 8 percent.

Permeability is rapid in the Sheppard soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

The Monue soil is deep and well drained. It formed in loamy eolian deposits. Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is brown very fine sandy loam about 29 inches thick. The upper 26 inches of the substratum is light brown very fine sandy loam. The lower part to a depth of 84 inches or more is brown and light brown sandy loam. In some areas lenses of gravelly sandy loam are below a depth of 30 inches. In some places on the Moenkopi Plateau, the soil is 40 to 60 inches deep.

Permeability is moderately rapid in the Monue soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. A few areas are used for dryland farming. These soils can be used as irrigated cropland if water becomes available. The Monue soil has more potential as irrigated cropland than the Sheppard soil.

The potential plant community on the Sheppard soil is mainly Indian ricegrass, needleandthread, blue grama, galleta, Cutler Mormon tea, and sand sagebrush. If the range is improperly used, galleta, sandhill muhly, Fendler threeawn, broom snakeweed, and sand sagebrush increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

The potential plant community on the Monue soil is mainly Indian ricegrass, blue grama, galleta, needleandthread, Cutler Mormon tea, and fourwing saltbush. If the range is improperly used, galleta, Fendler threeawn, Cutler Mormon tea, broom snakeweed, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, and annual forbs invade.

Proper grazing practices are essential. If these soils are overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If these soils are used as cropland, irrigation is needed for maximum production. Because of the slope and the intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind and by maintaining crop residue on the surface. A cropping system that includes a close-growing, high-residue crop in the rotation helps to control soil blowing and improves soil tilth and the content of organic matter. Keeping the surface moist during the spring also helps to control soil blowing.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site of the Sheppard soil is Sandy Upland, 6- to 10-inch precipitation zone, and that of the Monue soil is Sandy Loam Upland, 6- to 10-inch precipitation zone.

33—Sheppard-Nakai complex, 1 to 8 percent slopes. This map unit is on plateaus. Elevation is 5,100 to 5,400 feet. The mean annual precipitation is 6 or 7 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit is 45 percent Sheppard loamy sand and 40 percent Nakai very fine sandy loam. The two soils occur as areas so closely intermingled that it was not practical to map them separately at the scale used. The Sheppard soil is on dunes, and the Nakai soil is between the dunes.

Included in mapping are small areas of Monue soils on fan terraces adjacent to dunes, Tewa soils in swales on stream terraces, and moderately deep, sandy and loamy soils on plateaus. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

The Sheppard soil is deep and somewhat

Figure 9.—This 1936 photograph of an area in the Sandy Upland range site shows a sparse cover of galleta, sandhill muhly, Indian ricegrass, and fourwing saltbush. Note the areas of bare ground.

excessively drained. It formed in eolian deposits derived dominantly from sandstone. Typically, the surface layer is yellowish red loamy sand about 9 inches thick. The underlying material to a depth of 84 inches or more is brown and reddish yellow fine sand. In some areas the surface layer is fine sand.

Permeability is rapid in the Sheppard soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe.

The Nakai soil is deep and well drained. It formed in eolian deposits over alluvium derived dominantly from sandstone and shale. Typically, the surface layer is strong brown very fine sandy loam about 3 inches thick. The upper part of the subsoil is strong brown and light brown very fine sandy loam about 31 inches thick. The lower part to a depth of 84 inches or more is reddish yellow and light brown fine sandy loam. In some areas the surface layer is loamy fine sand.

Permeability is moderately rapid in the Nakai soil. Available water capacity is moderate. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe. The content of calcium carbonate is more than 15 percent below a depth of 20 inches.

This unit is used for grazing. The Sheppard soil is poorly suited to the production of wild herbaceous plants and shrubs for wildlife habitat, but the Nakai soil is moderately suited. These soils can be used as irrigated cropland if water becomes available.

The potential plant community on the Sheppard soil is mainly Indian ricegrass, needleandthread, blue grama, galleta, Cutler Mormon tea, and sand sagebrush. If the range is improperly used, galleta, sandhill muhly, Fendler threeawn, broom snakeweed, and sand sagebrush increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

The potential plant community on the Nakai soil is mainly Indian ricegrass, galleta, blue grama, bottlebrush squirreltail, Cutler Mormon tea, winterfat, and fourwing saltbush. If the range is improperly used, galleta, Fendler threeawn, Cutler Mormon tea, broom

Figure 10.—This 1982 photograph of the same area shows improved rangeland as a result of proper grazing use.

snakeweed, and Greene rabbitbrush increase. If the vegetation is allowed to deteriorate further, cheatgrass, sixweeks fescue, and annual forbs invade.

Proper grazing practices are essential. If these soils are overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pasture during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation and the hazard of soil blowing following seedbed preparation. Timely seeding is essential if seedlings are to be established. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

If these soils are used as cropland, irrigation is needed for maximum production. Because of the slope and the intake rate, sprinkler or drip irrigation systems are the most suitable for row crops. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts that are sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Soil blowing can be controlled by stripcropping at right angles to the prevailing wind and by maintaining crop residue on the surface. Establishing field windbreaks and using a crop rotation that includes a close-growing cover crop also help to control soil blowing. Lime in the subsoil of the Nakai soil causes chlorosis in some plants. Chlorosis can be prevented by applying soil amendments or plant sprays.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site of the Sheppard soil is Sandy Upland, 6- to 10-inch precipitation zone, and that of the Nakai soil is Sandy Loam Upland, 6- to 10-inch precipitation zone.

34—Sheppard-Torriorthents complex, 1 to 8 percent slopes. This map unit is on plateaus. Elevation is 4,800 to 5,300 feet. The mean annual precipitation is 6 or 7 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

This unit is 60 percent Sheppard sand on dunes and 25 percent Torriorthents in depressions. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in mapping are small areas of Ives soils on flood plains, Joraibi soils on alluvial fans, and Jeddito and Naha soils in areas between dunes on stream terraces. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian deposits derived dominantly from sandstone. Typically, the surface layer is reddish brown sand about 2 inches thick. The underlying material to a depth of 84 inches or more is reddish brown sand. It is sodic below a depth of 30 inches. In some areas the surface layer is loamy sand.

Permeability is moderately rapid in the Sheppard soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is very severe. The sodium adsorption ratio ranges from 10 to 15.

The Torriorthents consist of actively eroding structural benches that are almost completely bare of vegetation. These areas have a dense, crusted surface layer that is strongly alkaline or very strongly alkaline. Textures of the surface layer and underlying material are highly variable, ranging from sand to clay. These soils are sodic.

Permeability ranges from moderately rapid to slow in the Torriorthents. Available water capacity ranges from low to high. Potential rooting depth ranges from 10 to more than 60 inches. The hazard of soil blowing is moderate or severe.

This unit is used for grazing. It is poorly suited to the production of wild herbaceous plants and shrubs for wildlife habitat. Cultivation is difficult because of the intermingled areas of Torriorthents.

The potential plant community on the Sheppard soil is mainly alkali sacaton, Indian ricegrass, galleta, sandhill muhly, and fourwing saltbush. If the range is improperly used, alkali sacaton, galleta, sandhill muhly, broom snakeweed, and annual forbs increase.

Proper grazing practices are essential. If these soils are overgrazed, controlling soil blowing is extremely difficult. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. Seeding a suitable plant cover helps to control blowing and drifting of sand. The main limitations affecting range seeding are low precipitation, the content of sodium, and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Plants that tolerate salt should be selected for seeding. Timely seeding is essential for the establishment of seedlings. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Leaving strips of native vegetation at right angles to the prevailing wind helps to prevent soil blowing during seedbed preparation. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

The capability subclass is VIIe. The range site of the Sheppard soil is Sandy Upland (Sodic), 6- to 10-inch precipitation zone. A range site is not assigned for the Torriorthents.

35—Strych-Rock outcrop complex, 25 to 60 percent slopes. This map unit is on hills of basalt-capped mesas and buttes (fig. 6). Elevation is 5,800 to 6,700 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 130 to 150 days.

This unit is 70 percent Strych soil and 20 percent Rock outcrop. The components of this unit occur as areas so closely intermingled that it was not practical to map them separately at the scale used.

Included in mapping are small areas of soils, on fan terraces, that are similar to Kinan soils but are shallow or moderately deep and areas of Mido soils on climbing and trailing dunes. Included areas make up about 10 percent of the unit. The percentage varies from one area to another.

The Strych soil is deep and well drained. It formed in eolian deposits and colluvium derived dominantly from sedimentary rocks. Rock fragments on the surface are

dominantly basalt. Typically, the surface layer is brown extremely cobbly fine sandy loam about 2 inches thick. The upper 7 inches of the subsoil is brown very gravelly loam. The lower part to a depth of 60 inches or more is brown and strong brown very stony and extremely stony fine sandy loam. In some areas the surface layer is gravelly fine sandy loam or very gravelly clay loam.

Permeability is moderately rapid in the Strych soil. Available water capacity is low. Potential rooting depth is 60 inches or more. The hazard of soil blowing is slight.

Rock outcrop consists of exposed areas of fractured basalt flows and sedimentary rocks.

This unit is used for grazing. The potential plant community is mainly muttongrass, galleta, black grama, desert needlegrass, blue grama, green Mormon tea, and Bigelow sagebrush. If the range is improperly used, galleta, green Mormon tea, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, cheatgrass and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Overgrazing reduces the plant cover and increases the risk of erosion. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Seeding generally is not practical because of the slope, the rough terrain, and the content of rock fragments. The slope limits access by livestock and results in overgrazing in the less sloping areas.

This unit is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. The rough terrain provides cover for wildlife. The amount of vegetation produced is low compared to other sites, but the variety of vegetation attracts many species. The Rock outcrop is used for nesting, resting, hunting perches, and courting grounds by eagles, hawks, and owls.

The capability subclass of the Strych soil is VIs. The range site is Breaks, 10- to 14-inch precipitation zone. The Rock outcrop is not assigned a capability subclass or a range site.

36—Tewa very fine sandy loam, 1 to 5 percent slopes. This deep, well drained soil is on stream terraces (fig. 8). It formed in mixed alluvium derived dominantly from sandstone and shale. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is light yellowish brown very fine sandy loam about 1 inch thick. The upper 24 inches of the subsoil is yellowish brown sandy clay loam and clay loam. The lower part to a depth of 84 inches or more is dominantly brown fine sandy loam and sandy clay loam. In some areas the surface layer is reddish brown. In other areas the surface layer is clay loam.

Included in mapping are small areas of Cannonville soils on hills, Jeddito soils on stream terraces, Jocity soils on alluvial fans, Monue soils in hummocky areas on fan terraces, and Wepo soils in swales and near shale knolls on stream terraces. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is moderately slow in the Tewa soil. Available water capacity is high. Potential rooting depth is 60 inches or more. The hazard of soil blowing is severe. This soil is subject to rare, very brief periods of shallow flooding from overland flow during high-intensity storms in early spring and summer. The sodium adsorption ratio is as high as 4 below a depth of 30 inches.

This unit is used for grazing. It is well suited to the production of wild herbaceous plants and shrubs for wildlife habitat. A few areas are used for dryland farming. This soil can be used as irrigated cropland if water becomes available.

The potential plant community is mainly galleta, blue grama, Indian ricegrass, bottlebrush squirreltail, alkali sacaton, fourwing saltbush, and winterfat. If the range is improperly used, galleta, Fendler threeawn, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, cheatgrass, Russian-thistle, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation and the hazard of soil blowing following seedbed preparation. The plants selected for seeding should meet the seasonal

requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established. This soil is suited to the construction of livestock water impoundments.

If this soil is used as cropland, irrigation is needed for maximum production. Basin, graded furrow, graded border, drip, and sprinkler irrigation systems work well on this soil. Basin irrigation systems are suitable in the nearly level areas, and sprinkler irrigation systems work well in the more sloping areas. If furrow or border irrigation systems are used, runs should be on the contour or across the slope. Subsoiling increases the rate of water infiltration. Maintaining crop residue on or near the surface helps to control runoff and erosion and maintains soil tilth and the content of organic matter. The risk of flooding can be reduced by using dikes and diversions.

The capability subclass is IIIe, irrigated, and VIIe, nonirrigated. The range site is Loamy Upland, 6- to 10-inch precipitation zone.

37—Torrifluvents, 0 to 2 percent slopes. These deep, somewhat poorly drained to well drained soils are on bars and channels of flood plains along deeply incised drainageways, such as Polacca, Dinnebito, and Oraibi Washes. The soils formed in alluvium derived dominantly from sandstone and shale. Elevation is 4,900 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are fine textured to coarse textured and are subject to frequent flooding.

Included in mapping are small areas of Ives, Jocity, and flooded soils that are similar to Polacca and Wepo soils on flood plains. Also included are small areas of riverwash in active channels that are devoid of vegetation. Included areas make up 10 percent of the unit. The percentage varies from one area to another.

Flooding limits the use of this unit. In some places the low stream terraces are used for farming.

These soils are well suited to the production of riparian shrubs, trees, vines, and herbaceous plants for wildlife habitat.

The seasonal high water table and seep areas provide extra moisture for the growth of trees, such as cottonwood, ash, willow, walnut, and Russian-olive. These trees are used by cavity-nesting birds, such as woodpeckers, owls, and sparrow hawks. Hawks and eagles hunt in areas of these soils, and rabbits and deer feed on the browse. Trees should be replanted in wet streambeds and protected from grazing. Hardwoods have been used to make awls, and reeds are used to make flutes. This unit is an oasis of water-loving vegetation in a vast area of dry land. It is like a magnet for plants, animals, insects, and reptiles.

The present vegetation in most areas is mainly saltcedar, Russian-olive, rubber rabbitbrush, sedge, common reed, Indian ricegrass, alkali sacaton, cocklebur, and annual forbs.

The capability subclass is VIIw. No range site is assigned.

38—Travessilla-Rock outcrop complex, 1 to 8 percent slopes. This map unit is on plateaus and mesas. Elevation is 5,900 to 6,700 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

This unit is 50 percent Travessilla soil and 35 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in mapping are small areas of Begay soils on plateaus, moderately deep soils similar to Begay soils on adjacent dunes, and Mido soils on small, isolated dunes. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

The Travessilla soil is very shallow and shallow and is well drained. It formed in loamy eolian deposits derived dominantly from sandstone. Typically, the surface layer is brown very fine sandy loam about 1 inch thick. The subsoil is brown fine sandy loam about 6 inches thick. The substratum is brown very fine sandy loam about 4 inches thick. Sandstone is at a depth of about 11 inches. The depth to sandstone ranges from 6 to 17 inches. In some areas the surface layer is loamy fine sand.

Permeability is moderately rapid in the Travessilla soil. Available water capacity is very low. Potential rooting depth is 6 to 17 inches. The hazard of soil blowing is moderate.

This unit is used for fuel wood or for grazing. It is well suited to the production of coniferous trees for wildlife habitat.

The potential plant community on the Travessilla soil is mainly Utah juniper, pinyon pine (25 to 35 percent canopy), and an understory of Bigelow sagebrush, Stansbury cliffrose, Indian ricegrass, needleandthread, and galleta. If the range is improperly used, Utah juniper, pinyon pine, Bigelow sagebrush, galleta, Greene rabbitbrush, and thrifty goldenweed increase. If the vegetation is allowed to deteriorate further,

cheatgrass and annual forbs invade.

The Travessilla soil is suited to the production of Utah juniper and pinyon pine for use as fuel wood, fence posts, and Christmas trees. It can produce 2 or 3 cords per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. Production of understory vegetation averages about 400 pounds per acre. Thinning dense stands of trees increases the production of understory forage plants. Management measures that minimize the hazard of erosion are needed when wood is harvested for fuel or fence posts.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Properly locating livestock watering facilities promotes uniform distribution of livestock grazing. Seeding generally is not practical in areas of the Travessilla soil because of the very low available water capacity. Chaining is not practical.

The capability subclass of the Travessilla soil is VIIe. The woodland site is Sandstone Upland (J-P), 10- to 14-inch precipitation zone. The Rock outcrop is not assigned a capability subclass or a woodland site.

39—Typic Torriorthents, 10 to 35 percent slopes. This map unit is on active and metastable hills on mesas. Slopes are complex. The soils formed in colluvium and alluvium derived dominantly from soft sedimentary rocks. Elevation is 5,000 to 5,900 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Torriorthents are very shallow to moderately deep and are well drained. The texture of the surface layer varies considerably. It is sand, loamy sand, sandy loam, sandy clay loam, or clay. The content of rock fragments ranges from 0 to 65 percent. The underlying material is variable. It is sand, loamy sand, sandy loam, clay loam, or clay. The depth to sandstone or shale ranges from 2 to 40 inches.

Included in mapping are small areas of Sheppard soils on dunes, shallow soils that have accumulations of calcium carbonate, and areas of rock outcrop on steep escarpments. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is variable in the Typic Torriorthents. It ranges from moderately rapid to slow. Available water capacity is low or medium. Potential rooting depth is 2 to 40 inches. The hazard of soil blowing is moderate or severe.

This unit has limited potential for any use. Some areas are used for grazing. These soils are moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat. The broken topography and the variety of vegetation attract many species of wildlife.

The potential plant community is mainly galleta, Indian ricegrass, alkali sacaton, Torrey Mormon tea, shadscale, Bigelow sagebrush, and fourwing saltbush. If the range is improperly used, galleta, sandhill muhly, Fendler threeawn, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

This unit can be grazed by a few livestock for limited periods of time. Areas of these soils are actively eroding. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing. Seeding generally is not practical because of the slope, the rough terrain, and the content of gravel and cobbles on the surface. The slope limits access by livestock and results in overgrazing in the less sloping areas.

The capability subclass is VIIe. The range site is Breaks, 6- to 10-inch precipitation zone.

40—Ustic Torriorthents, 10 to 35 percent slopes. This map unit is on active and metastable hills on mesas. Slopes are complex. The soils formed in colluvium and alluvium derived dominantly from soft sedimentary rock. Elevation is 5,800 to 6,700 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 51 to 52 degrees F, and the frost-free period is 130 to 150 days.

Torriorthents are very shallow to deep and are well drained. The texture of the surface layer varies considerably. It is loamy sand, sandy loam, fine sandy loam, clay loam, or clay. The content of rock fragments ranges from 0 to 45 percent. The underlying material is variable. It is loamy sand, fine sandy loam, clay loam, sandy clay, or clay. The depth to soft sedimentary rock ranges from 4 to more than 60 inches.

Included in mapping are small areas of Mido soils on dunes, Milok soils on plateaus, and areas of rock outcrop on escarpments. Also included are small areas of deep, flooded, clayey soils in intermittent

drainageways. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is variable in the Ustic Torriorthents. It ranges from moderately rapid to slow. Available water capacity ranges from low to high. Potential rooting depth ranges from 4 to more than 60 inches. The hazard of soil blowing is moderate or severe.

This unit has limited potential for any use. Some areas are used for grazing.

These soils are moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat, but they are poorly suited to coniferous trees. The potential plant community is mainly Indian ricegrass, muttongrass, galleta, needleandthread, Bigelow sagebrush, Stansbury cliffrose, and scattered Utah juniper and pinyon pine. The canopy cover is less than 10 percent. If the range is improperly used, Utah juniper, Stansbury cliffrose, Greene rabbitbrush, galleta, and bottlebrush squirreltail increase. If the vegetation is allowed to deteriorate further, annual grasses and forbs invade.

This unit can be grazed by a few livestock for limited periods of time. Areas of these soils are actively eroding. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing. Seeding generally is not practical because of the slope, the rough terrain, and the content of coarse fragments. The slope limits access by livestock and results in overgrazing in the less sloping areas.

The capability subclass is VIIe. The range site is Breaks, 10- to 14-inch precipitation zone.

41—Uzona loam, 0 to 2 percent slopes. This deep, well drained, saline-sodic soil is on stream terraces. It formed in alluvium derived dominantly from shale and sandstone. Elevation is 5,200 to 5,400 feet. The mean annual precipitation is 6 to 8 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is light yellowish brown loam about 1 inch thick. The upper 4 inches of the subsoil is yellowish brown, saline and sodic clay loam. The lower 27 inches is yellowish brown and light brown, saline and sodic clay. The upper 26 inches of the substratum is light yellowish brown, saline and sodic sandy clay and sandy clay loam. The lower part to a depth of 84 inches or more is very pale brown fine sand. In some areas the surface layer is clay loam.

Included in mapping are small areas of Jocity soils on flood plains and Polacca and Wepo soils on stream terraces. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is very slow in the Uzona soil. Available water capacity is very low. The high salt content reduces the amount of moisture available for plant growth. Potential rooting depth is 84 inches or more. The hazard of soil blowing is moderate. This soil is subject to rare, very brief periods of flooding during high-intensity storms in early spring and summer. The sodium adsorption ratio commonly is more than 200, and electrical conductivity is commonly more than 50 millimhos per centimeter.

This unit is used for grazing. It is moderately suited to the production of wild herbaceous plants and shrubs for wildlife habitat.

The potential plant community is mainly alkali sacaton, galleta, western wheatgrass, inland saltgrass, mound saltbush, and fourwing saltbush. If the range is improperly used, black greasewood, mound saltbush, Torrey seepweed, and annual forbs increase.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Range recovery is slow because the soil is saline and sodic. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation, the salt-sodium content, crusting, and compaction of the soil during and following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Plants that tolerate very high salt concentrations should be selected for seeding. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established.

The capability subclass is VIIs. The range site is Saline Bottom, 6- to 10-inch precipitation zone.

42—Wepo clay loam, 0 to 3 percent slopes. This deep, well drained soil is on stream terraces. It formed in mixed alluvium derived dominantly from shale and sandstone. Elevation is 5,100 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Typically, the surface layer is pale brown clay loam about 3 inches thick. The subsoil, to a depth of about 32 inches, is pale brown and brown clay loam and clay that have thin strata of coarser material. The substratum to a depth of 84 inches or more is pale brown and light yellowish brown, slightly saline, stratified clay, silt loam, very fine sandy loam, loam, and sand. In some areas the surface layer is fine sandy loam.

Included in mapping are small areas of Ives and Jocity soils on flood plains and Polacca soils on stream terraces. Also included are deep, fine textured soils on stream terraces that are not stratified and, in the extreme southwest part of the survey area, small areas of Wepo soils that have a moderate content of sodium. Included areas make up about 15 percent of the unit. The percentage varies from one area to another.

Permeability is slow in the Wepo soil. Available water capacity is high. Potential rooting depth is 60 inches or more. The hazard of soil blowing is slight. This soil is subject to rare, very brief periods of flooding during high-intensity storms in early spring and summer. Electrical conductivity can exceed 4 millimhos per centimeter below a depth of 40 inches.

Most areas are used for grazing. This soil is moderately suited to wild herbaceous plants and shrubs for wildlife habitat. A few small areas are used for dryland farming. The soil can be used as irrigated cropland if water becomes available.

The potential plant community is mainly alkali sacaton, galleta, bottlebrush squirreltail, and fourwing saltbush. If the range is improperly used, galleta, mound saltbush, and broom snakeweed increase. If the vegetation is allowed to deteriorate further, black greasewood, Torrey seepweed, and annual forbs invade.

Proper grazing practices are essential. Maintaining an adequate plant cover helps to control erosion and encourages the production of forage. Grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Planned grazing systems help to maintain plant vigor and forage production. Using a grazing system that varies the season of grazing and the periods of rest in pastures during successive years results in a balanced plant community that includes a great variety of high-quality forage plants. Fencing and properly locating livestock watering facilities promote uniform distribution of livestock grazing.

If the range vegetation is seriously deteriorated, seeding helps recovery. The main limitations affecting range seeding are low precipitation, crusting and compaction of the surface soil, and the hazard of erosion following seedbed preparation. The plants selected for seeding should meet the seasonal requirements of livestock or wildlife, or both. Timely seeding is essential for the establishment of seedlings on this soil. A firm, weed-free seedbed should be prepared and the seed planted with a suitable drill. Grazing should be deferred in seeded areas for two growing seasons or until the plants are well established. This soil is suited to the construction of livestock water impoundments.

If this soil is used as cropland, irrigation is needed for maximum production. Basin, graded furrow, graded border, and drip irrigation systems are suitable. Basin irrigation systems work well in the more level areas. Applying the water at a slow rate over a long period helps to ensure that the root zone is properly wetted. Because of the slow permeability of this soil, the application of water should be regulated so that water does not stand on the surface and damage the crops. Good-quality irrigation water is needed to prevent the accumulation of salt. Because of the content of clay, this soil should be plowed in the fall. The soil cannot be easily tilled when it is dry, and it is subject to clodding and compaction if it is tilled when wet. The content of soil moisture is optimum for tillage for only a short period.

The capability subclass is IIIs, irrigated, and VIIs, nonirrigated. The range site is Clay Fan, 6- to 10-inch precipitation zone.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops

General management needed for crops is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified, and the system of land capability classification used by the Natural Resources Conservation Service is explained.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

Cropland

The majority of soils on the Hopi Indian Reservation have potential for crop production provided adequate water becomes available. Presently there is no source of irrigation water, except a few small springs. Soil characteristics that particularly influence crop production are sodicity, salinity, available water capacity, permeability, and soil depth.

Selected crops that can be grown are alfalfa, vegetables, barley, milo, and beans. The potential is high for good yields of onions, carrots, and potatoes. Potatoes are especially well adapted to moderately coarse textured, well drained and somewhat excessively drained soils, such as Monue, Jeddito, and Begay soils.

Sustained crop yields require proper management. Major cropland management objectives include proper irrigation, maintaining soil tilth and fertility, and controlling water erosion and soil blowing.

Irrigation system should be designed according to the crop grown and the characteristics of the soil. Timely and adequate applications of water are essential for high crop yields and water conservation. Sprinkler systems, for example, are well suited to Monue, Nakai, and Sheppard soils but work poorly in areas of soils that have a slow intake rate, such as Wepo and Polacca soils. Basin, border, or furrow irrigation systems, however, are suitable in areas of Wepo and Polacca soils. Drip irrigation is especially conducive to water conservation. The root zone should be kept moist, but overirrigation can leach plant nutrients below the root zone and can waterlog the soil.

Soil tilth and fertility can be enhanced by adding

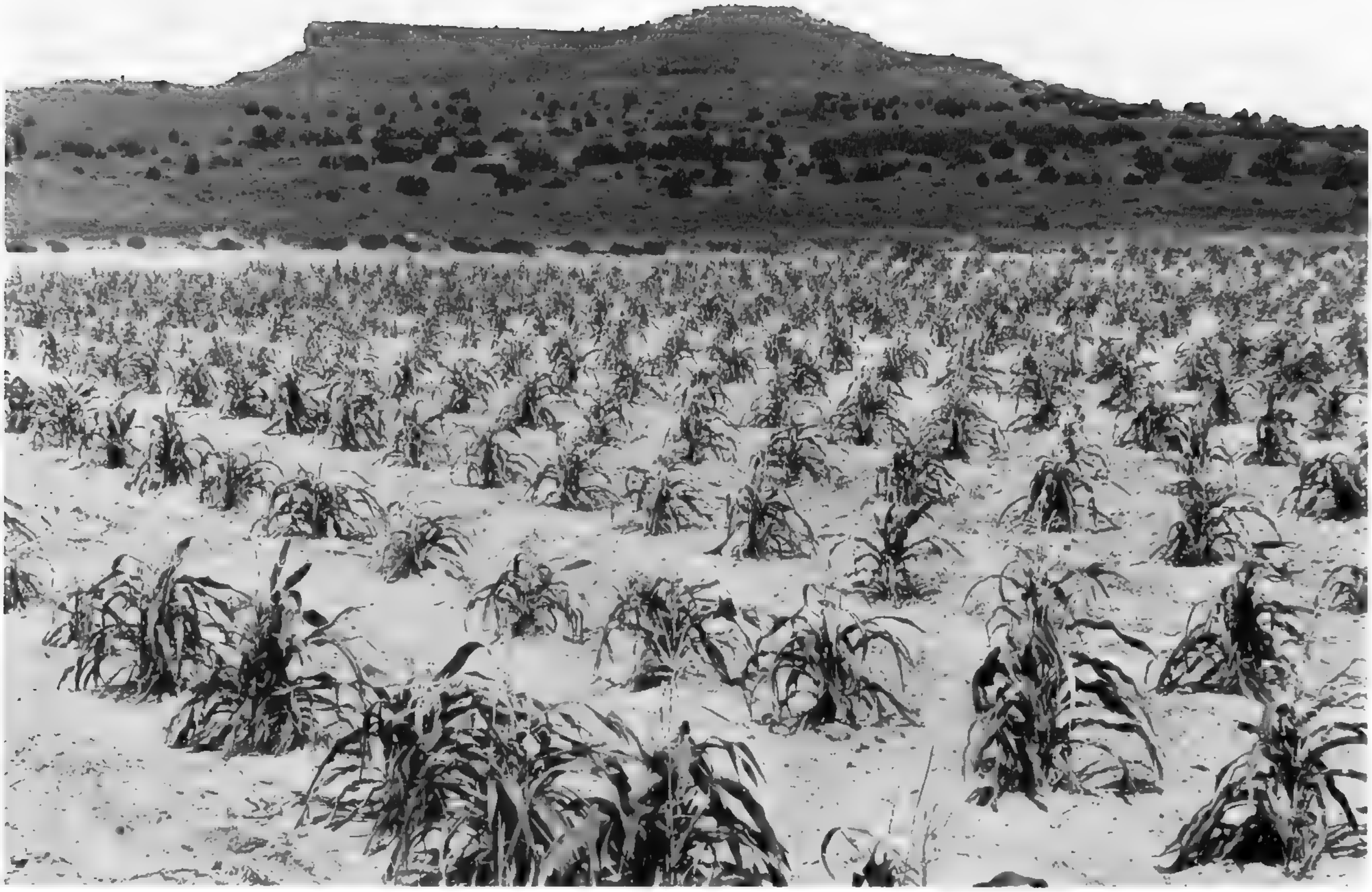

Figure 11.—A typical Hopi dryland cornfield in an area of Jeddito loamy sand, 0 to 5 percent slopes. Rows are spaced according to the farmer's estimate of soil moisture. (Photograph by Fred Kootswatewa, Hopi Tribe)

organic material. Organic matter helps to build stable soil aggregates, thus improving structure and tilth. Additions of organic matter improve aeration and water penetration in clayey soils, such as Wepo soils, and increase the water-holding capacity of sandy soils, such as Sheppard and Mido soils. Also, organic matter is a good reservoir for holding plant nutrients within the root zone, especially nitrogen and phosphorus.

Water erosion can become a problem if irrigation systems are poorly designed on sloping soils. On some soils, land leveling can reduce the slope and the runoff rate. Placing irrigation furrows across the slope or on the contour helps to control runoff and erosion. Proper management of crop residue also helps to control water erosion on sloping soils.

Soil blowing is a serious problem on soils that have a coarse textured surface layer. Large tracts of land in the survey area are highly susceptible to soil blowing, and intensive measures are needed to control erosion if the soils are cultivated. Maintaining the plant cover from the previous crop on the surface until the subsequent crop is planted provides adequate protection and helps to control soil blowing. Establishing windbreaks, planting crops in strips perpendicular to the wind, and minimizing tillage also help to control soil blowing. A cropping system that includes a close-growing, high-residue crop in the rotation reduces the hazard of soil blowing and improves soil tilth and the content of organic matter.

Yields of annual crops can be further increased by other management practices, including the use of improved crop varieties, timely planting and harvesting,

crop rotations, and a good fertilizer program. Controlling weeds, insects, and plant diseases also improves yields.

Dryland Farming

Deborah J. Prevost, soil scientist, Natural Resources Conservation Service, prepared this section.

The Hopi Indians are descendants of pueblo-agricultural people who migrated into the area during the first millennium A.D. These ancestral clans cultivated corn, beans, and cotton in nearly the same fields that are used for farming today (fig. 11). The earliest farming areas on the Hopi Reservation date back to 500 A.D. *(4)*. Extensive floodwater farming, using runoff from upland areas to flood fields, was practiced in most years between 1000 and 1900 A.D., until the current epicycle of erosion downcut drainageways and destroyed many farming areas *(26)*.

Corn was the principal crop and the mainstay of life. The ability of an area of land to produce corn determined the location of the pueblo and sometimes its abandonment during climatic changes. Agriculture encouraged the development of a sedentary, communal society with a rich religious-cultural-political system *(23)*. Raising corn became an integral part of spiritual life. Farming concepts, such as the promotion of fertility and growth and the stimulation of rain, are important in many religious ceremonies. The kernels, stalks, leaves, meal, and pollen of corn are used in nearly every ritual *(33)*.

Although crops have been produced for more than 1,000 years, crop production on Hopi land is considered economically unfeasible by modern standards. Soils are generally deep and arable, but crop production is limited by the climate and a lack of irrigation water. The growing season averages 130 to 160 days, with the last spring frost in mid-May and the first fall frost in late September. Hopi corn varieties require 115 to 130 days to reach maturity. Average annual precipitation in agricultural areas is 8 to 12 inches and is insufficient to produce most crops. Rainfall is concentrated as localized, violent summer storms and is highly variable from year to year. A 2- to 3-inch decrease in precipitation can cause a 15 to 30 percent decrease in crop yields *(23)*. Surface water is scarce, and only 3 to 6 percent of an entire drainage basin may be farmed. Runoff water from a drainage area of 230 to 320 acres is needed to flood a 15-acre field *(15)*. Strong winds are common during the spring planting months, when less than 1 inch of precipitation is normally received *(23)*. These winds increase the evaporation rate and damage young plants with abrasion from blowing sand. Rodents and insects are additional problems and eat corn at every stage of its growth.

The Hopi farmer has overcome many of these limitations by the careful selection of field locations, highly specialized and labor-intensive farming techniques (fig. 12), and the use of adapted crops *(24)*.

The success of farming a field depends greatly on its physiographic location and its proximity to water. Fields are established in four general positions—on alluvial fans at the mouth of small intermittent drainageways, where water spreads across the land naturally after storms; on low stream terraces adjacent to wide drainageways that are flooded during major storms; on sand dunes watered by rainfall and limited underground seepage; and on artificial terraces constructed near springs to catch available water. The majority of the fields are farmed by floodwater techniques on alluvial fans and flood plains. Farming on sand dunes is not extensive. Spring-fed water for farming on terraces is used to a limited extent for specialty crops and gardens.

Hopi farmers have developed special techniques that allow the production of crops in an otherwise hostile environment. They have accomplished this by taking advantage of micro-niches in the environment. The fields are typically small, 1 to 5 acres, and are widely scattered, which helps to control soil blowing. The fields are cleared by hand or by cultivator in February and are left idle until April. The planting season ranges from mid-April for early ceremonial corn to June for the principal corn crop *(7)*. Other crops include beans, melons, and squash. Onions, tomatoes, cabbage, chili, carrots, lettuce, and other vegetables are grown in small irrigated gardens. Peaches, apricots, and apples are grown in small orchards. Crops are harvested from July through September *(15)*.

The traditional farmer plants corn by clearing the surface with his foot and making a narrow hole 6 to 12 inches deep, depending on soil and moisture conditions. The hole is made with a digging stick. The soil is loosened a few inches below this depth, and 10 to 20 kernels are dropped into the hole. The soil is returned and packed by hand. The rows are staggered between the stubble of the previous year's growth and spaced according to the farmer's estimate of soil moisture, usually 3 or 4 paces *(5)*. Conservation practices are inherent in these methods. The digging stick is a form of minimum tillage, leaving most of the surface intact and thus less susceptible to erosion. Hopi corn varieties have an elongated epicotyl adapted to deep planting. Deep planting allows the seed to be placed in a zone of soil moisture reserve and protects the germinating seed from frost and wind damage. It is especially effective in areas that have 10 to 12 inches of sandy soil over a loamy subsoil. The sand acts as a mulch, allowing rapid infiltration of water and retaining moisture in the root zone for long periods *(15)*. The

Figure 12.—Labor-intensive farming techniques include removing the outer leaves to ensure a productive crop.

planting of many kernels ensures emergence in spite of cutworms and other predators. The clustered survivors provide support and shelter for the inner plants. The staggered rotation of planting sites allows the soil to regain fertility, and wide spacing efficiently utilizes the limited soil moisture.

Many cultivation techniques also are conservation oriented. Temporary earthen, brush, or rock dams and dikes are used to divert and spread water over fields *(23)*. Low ridges are built around seedlings to trap moisture. Shallow, selective hoeing and weeding conserve soil moisture and help to control erosion. Artificial terraces trap silt and moisture and reduce the erosive power of the water. Plants are protected from soil blowing by various kinds of windbreaks. Large stones or tin cans are placed around individual plants. Rows of brush, held by stones, are implanted in the soil perpendicular to the wind direction *(15)*. Plants are grown on the leeward side of dead stalks, where sand accumulates and blocks the wind.

These techniques are highly adapted to the local environment but require a great deal of labor. Crop yields are low. An acre may produce only 10 to 15 bushels of corn *(5)*.

Hopi agricultural practices are adjusting to recent climatic, social, and economic changes. Severe arroyo cutting occurred around the turn of the century, dissecting fields, lowering the water table, and decreasing floodwater farming by at least 25 percent *(15)*. The climate has become drier, forcing marginal

fields out of existence *(7)*. The use of pickup trucks and tractors has facilitated a shift to larger fields at greater distances from the villages. Agriculture is no longer the sustaining economic base. Many people are employed by the tribe, Federal agencies, and small businesses. The total acreage used for agricultural production has decreased by more than 50 percent since 1950. Traditional Hopi agriculture is declining but is still practiced in a few limited areas, mainly on Third Mesa near the village of Hotevilla.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(27)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

Harmon S. Hodgkinson, range conservationist, Natural Resources Conservation Service, helped prepare this section.

About 85 percent of the land in the survey area is rangeland. Most of the range is used throughout the year. Cattle are the most common livestock, although sheep, goats, and horses also use the range resources. Cow-calf operations and the grazing of the horses are conducted within various range units that are commonly 35,000 acres or more in size. The sheep and goats use the range within the boundaries of the farming units. A herder stays with the sheep and goats to keep them out of the crop fields. These range areas are about 17,000 acres in size. The land is Indian trust land and is administered by the Bureau of Indian Affairs.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 5 shows, for each soil that supports rangeland vegetation suitable for grazing, the range site; the potential annual production of vegetation in favorable, normal, and unfavorable years; and the average percentage of each species. An explanation of the column headings in table 5 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants.

The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and topographic position are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Since the rangeland in the survey area is used throughout the year, the main management goal should be to use the native forage plants at an intensity that maintains or improves the quantity and quality of the vegetation for soil protection and forage production. This range management practice is called proper grazing use. Most native herbaceous forage plants remain vigorous and produce good leaf growth if at least 50 percent of the annual production, by weight, remains at the end of the grazing season. Proper grazing use involves a system that moves the animals from the forage resource when the desired level of use has occurred.

The majority of the rangeland that is in only fair condition is a result of grazing the same plants every year during the green growth period. The practice of year-long grazing in large units with no periods of rest makes it difficult for the plants to remain vigorous and healthy. Establishing a grazing system in which the plants are not grazed during the green growth period at least once in 3 years or only every other year helps to maintain the productivity of the rangeland.

There are many types of grazing systems. A system can be developed to fit the plant and livestock needs. The placement of fencing and watering facilities is a crucial part of establishing a grazing system and promoting uniform distribution of livestock.

The native plant community has been depleted by excessive grazing use and past farming practices along the major washes, which include Jeddito, Polacca, Oraibi, Dinnebito, Wepo, and Moenkopi Washes, in other isolated areas, and in areas adjacent to homes, where livestock naturally are allowed to congregate. This grazing pattern has been occurring over a long period of time. As a result, most of these areas are in poor condition. Other areas in poor condition are abandoned crop fields. These fields are generally 1 to 5 acres in size and are scattered throughout the vast area of rangeland.

Areas of range in poor condition should be seeded to species that can balance the yearly nutritional needs of the grazing animals. Species for early spring and winter use are particularly important. The native forage is nutritious and green from April to September if the precipitation was good in winter and summer. The seeded area should be large enough to be managed as a unit within the grazing system. Pastures for early spring use could be developed along most washes in the designated grazing areas, away from any conflict with the farming areas. These spring pastures would make excellent calving areas.

Some range sites are better suited to seeding than

others. In the 6- to 10-inch precipitation zone, the Loamy Upland, Sandy Loam Upland, and Sandy Terrace sites are the best suited. The soils in these areas have the fewest limitations affecting range seeding. Up-to-date technology should be used to establish the seedlings. A weed-free seedbed minimizes plant competition. A firm seedbed can be established by using a culti-packer or imprinter. Late fall is the best time to seed. The dormant seed will germinate in the spring, thereby taking advantage of winter and early spring moisture.

In the 10- to 14-inch precipitation zone, the Loamy Upland and Sandy Loam Upland sites are the best suited for range seeding where the range is in poor condition. Preparing a firm, weed-free seedbed allows for maximum moisture at the shallow depth of seed placement. A suitable drill is very important when seedlings are established. Late fall is the best time to seed in this precipitation zone. The dormant seed will germinate in the spring, thereby taking advantage of winter and spring moisture. If a good seedbed is prepared and proper seeding techniques are used, supplemental irrigation will not be needed for the establishment of good stands.

In some areas, primarily in the Sandy Loam Upland range site, brush species, such as Wyoming big sagebrush, broom snakeweed, and Greene rabbitbrush, have increased beyond the percentage desired in the native potential plant community. If these species are controlled, the more nutritional plants will be allowed to grow. Keeping the plant composition as close as possible to that in the native potential plant community also helps to protect the soils from erosion.

The areas that are best suited to brush management are those that support the desirable understory species, which respond to the water and nutrients that become available when the brush is removed. These areas are generally in fair condition. If no understory species exist, seeding will be necessary after brush management.

Methods of brush management include burning, rotobeating, plowing, and biological and chemical methods. The type of management applied depends on the species of brush.

Long-term improvement programs and good range management result in a balanced plant community that stabilizes the soil resource (figs. 13 and 14).

Woodland

Harmon S. Hodgkinson, range conservationist, Natural Resources Conservationist Service, prepared this section.

About 15 percent of the survey area is woodland. Utah juniper and pinyon pine are the species produced. Fuel wood and fence posts are the main woodland products. Understory vegetation provides limited grazing until the tree canopy exceeds the potential for the site.

Specific information regarding plant composition, management, and production is available in the section "Detailed Soil Map Units."

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter. The density of the canopy determines the amount of light that understory plants receive. The total production of understory vegetation includes the herbaceous plants and the leaves, twigs, and fruit of woody plants to a height of 4½ feet.

Wildlife Habitat

David W. Seery, area biologist, Natural Resources Conservation Service, prepared this section.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

There are four main types of wildlife habitat in the survey area. These are described in the following paragraphs.

High Plateaus and Mesas

These areas support pinyon-juniper woodlands and grasslands on the gently undulating tops of plateaus and mesas. The side slopes and edges have shallow soils that support grasses and shrubs. Many birds and animals use pinyon nuts for food. Hawks and owls nest in juniper trees. Mule deer hide in the woodlands. Woodpeckers and bluebirds use holes in the trees for nesting.

Wide Alluvial Valleys

The flood plains and land near streams can support trees, such as cottonwood, Russian-olive, willow, ash, and walnut (figs. 15 and 16). These trees have been removed, but they could be reestablished in streambeds where soil moisture is adequate. Moenkopi Wash, Dinnebito Wash, and Jeddito Wash may be suitable sites. These areas are used by crows, rabbits, owls, skunks, and snakes.

Fan terraces and stream terraces are broad areas between the flood plains and the plateaus. These upland sites are the home of antelope, badgers, prairie

Figure 13.—This windmill was photographed in 1957, before brush management measures and other long-term improvements were undertaken.

dogs, and hawks. These grasslands also are used by cattle, sheep, and horses. Antelope could be reintroduced if they are protected until they become established.

Breaks

These are the steep, broken lands on the edges of mesas and plateaus. Breaks are highly eroded with many ridges and gullies. Vegetation grows on breaks but not in large amounts. The physical diversity of the area and the many different kinds of plants attract wildlife. Deer can hide in the breaks and feed on the weeds and browse. A fox must run only a short distance to be out of danger. Scattered trees in many

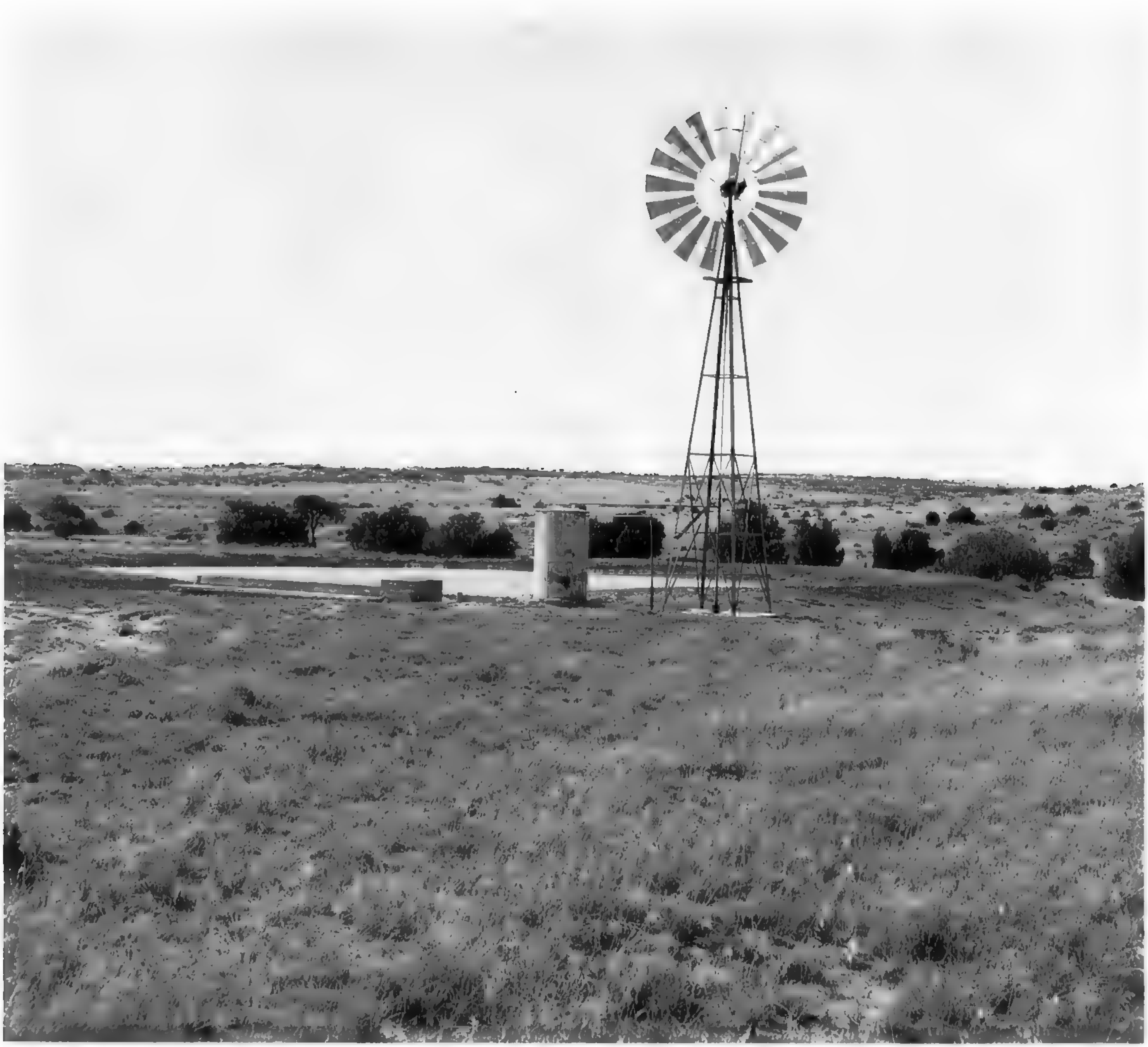

Figure 14.—This 1982 photograph shows the same area. A storage tank and a float-equipped watering trough have been added to provide flexibility to the system. The vigor of the *galleta* and blue grama has also improved.

of these areas provide hunting perches for hawks.

Rock Outcrop

These are the bluffs and cliffs on canyon sides and mesa edges. They support no vegetation but are important to many wildlife species. Eagles, hawks, owls, and swallows nest on cliffs and ledges. Bats roost in cracks and caves. Foxes, bobcats, and cougars have dens in overhangs and caves.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the

Figure 15.—This 1962 photograph shows Russian-olive trees that have been planted in a wash to reduce the runoff rate. The trees are 2 to 3 feet tall.

most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the

Figure 16.—The trees in this 1982 photograph of the same area are more than 20 feet tall. Wildlife habitat has been enhanced, and the trees also help to control erosion.

surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 6 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. Flooding, shrinking and swelling, and organic layers can cause the movement of footings. Depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, and frost action potential affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 7 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 7 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 7 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 7 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as the final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 8 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 8, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 9 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect irrigation and terraces and diversions.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts and sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind erosion or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 10 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(3)* and the system adopted by the American Association of State Highway and Transportation Officials *(2)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 11 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, salt content, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; *high*, more than 6 percent; and *very high*, greater than 9 percent.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates

are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are as follows:

1. Coarse sands, sands, fine sands, and very fine sands.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and sapric soil material.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.

8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Soil and Water Features

Table 12 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Table 12 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that

delineate flood-prone areas at specific flood frequency levels.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(28)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 13 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Fluvent (*Fluv*, meaning flood plain sediment, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Torrifluvents (*Torri*, meaning hot and dry, plus *fluvents*, the suborder of the Entisols that formed in flood plain sediment).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Torrifluvents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle size, mineral content, soil temperature regime, soil depth, and reaction. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed (calcareous), mesic Typic Torrifluvents.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(29)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(28)*. Unless otherwise indicated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Bacobi Series

The Bacobi series consists of moderately deep, well drained, moderately slowly permeable soils on fan terraces and pediments. These soils formed in eolian deposits over soft sedimentary rock. Slopes range from 1 to 5 percent. Elevation is 5,300 to 5,900 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 55 degrees F, and the frost-free period is 130 to 160 days.

These soils are fine-loamy, mixed, mesic Typic Haplargids.

Typical pedon of Bacobi fine sandy loam, 1 to 5 percent slopes, about 7 miles southwest of Oraibi; about 2,700 feet west and 2,000 feet south of the northeast corner of sec. 29, T. 28 N., R. 14 E.

A—0 to 2 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 4/4) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine vesicular pores; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bw—2 to 6 inches; brown (7.5YR 5/4) very fine sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; common very fine tubular pores; strongly effervescent; moderately alkaline; clear smooth boundary.

Bt—6 to 15 inches; brown (7.5YR 5/4) fine sandy loam, strong brown (7.5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine roots; many very fine tubular pores; common clay bridges between sand grains and few faint discontinuous clay films on faces of peds; strongly effervescent; moderately alkaline; clear smooth boundary.

Btk1—15 to 26 inches; mixed brown (7.5YR 5/4) and dark yellowish brown (10YR 4/4) sandy clay loam, brown (7.5YR 4/4) and dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and plastic; common very fine roots; common very fine tubular pores; common clay bridges between sand grains and few faint discontinuous clay films on faces of peds; common fine irregular lime accumulations; strongly effervescent; moderately alkaline; slightly sodic (SAR 5); clear smooth boundary.

Btk2—26 to 33 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; common clay bridges between sand grains and few faint discontinuous clay films on faces of peds; common fine rounded lime accumulations; strongly effervescent; moderately alkaline; slightly sodic (SAR 7); clear smooth boundary.

Bk—33 to 36 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; many very fine rounded lime accumulations; strongly effervescent; moderately alkaline; slightly sodic (SAR 10); abrupt smooth boundary.

2Cr—36 to 60 inches; interbedded sandstone and shale.

The depth to paralithic contact ranges from 20 to 39 inches. Calcium carbonate equivalent is less than 15 percent. The Bw horizon is fine sandy loam or very fine sandy loam. The Bt horizon is fine sandy loam and sandy clay loam.

Begay Series

The Begay series consists of deep, well drained, moderately rapidly permeable soils on plateaus. These soils formed in eolian deposits derived dominantly from sandstone. Slopes range from 1 to 8 percent. Elevation is 5,800 to 6,800 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 50 to 53 degrees F, and the frost-free period is 120 to 150 days.

These soils are coarse-loamy, mixed, mesic Ustollic Camborthids.

Typical pedon of Begay very fine sandy loam, in an area of Penistaja-Begay complex, 1 to 8 percent slopes, about 0.25 mile north of Keams Canyon; in an unsurveyed area interpolated to be 350 feet east and 1,200 feet south of the northwest corner of sec. 22, T. 28 N., R. 20 E.

A—0 to 1 inch; brown (7.5YR 5/4) very fine sandy loam, brown (7.5YR 4/4) moist; weak thick platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

AB—1 to 4 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; moderate medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; few fine tubular pores; strongly effervescent; mildly alkaline; clear smooth boundary.

Bw1—4 to 7 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; slightly effervescent; mildly alkaline; clear smooth boundary.

Bw2—7 to 12 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure;

slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; common fine lime accumulations in pores and root channels and few fine discontinuous coatings on faces of peds; strongly effervescent; moderately alkaline; gradual smooth boundary.

Bk1—12 to 20 inches; strong brown (7.5YR 5/6) very fine sandy loam, strong brown (7.5YR 4/6) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; common fine tubular pores; common fine lime accumulations in pores and root channels; strongly effervescent; moderately alkaline; gradual smooth boundary.

Bk2—20 to 27 inches; brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; common fine lime accumulations in pores and root channels; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk3—27 to 43 inches; brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium prismatic structure; hard, friable, slightly sticky and slightly plastic; common fine roots; common fine lime accumulations in pores and occurring as irregular masses; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk4—43 to 57 inches; strong brown (7.5YR 5/6) fine sandy loam, strong brown (7.5YR 5/6) moist; weak medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common fine tubular pores; few fine lime accumulations in pores and root channels; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk5—57 to 65 inches; reddish yellow (7.5YR 6/6) loamy fine sand, strong brown (7.5YR 5/6) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few fine tubular pores; few fine lime accumulations in pores and root channels; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk6—65 to 79 inches; reddish yellow (7.5YR 6/6) loamy fine sand, strong brown (7.5YR 5/6) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few fine tubular pores; few fine irregular lime accumulations; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk7—79 to 84 inches; reddish yellow (7.5YR 6/6) loamy fine sand, strong brown (7.5YR 5/6) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine irregular lime accumulations; strongly effervescent; moderately alkaline.

The A horizon is loamy sand or very fine sandy loam. The B horizon is very fine sandy loam, fine sandy loam, or loamy fine sand and has less than 5 percent calcium carbonate equivalent.

Bighams Series

The Bighams series consists of moderately deep, well drained, moderately permeable soils on plateaus and hills. These soils formed in eolian deposits and in the underlying alluvium derived dominantly from sandstone and shale. Slopes range from 1 to 8 percent. Elevation is 6,300 to 6,700 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

These soils are fine-loamy, mixed, mesic Ustollic Calciorthids.

Typical pedon of Bighams very fine sandy loam, 1 to 8 percent slopes, about 3 miles south-southwest of Keams Canyon; about 500 feet east and 2,800 feet south of the northwest corner of sec. 3, T. 27 N., R. 20 E.

A—0 to 2 inches; brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 4/2) moist; weak medium platy structure; soft, very friable, nonsticky and slightly plastic; common very fine roots; many very fine vesicular pores; slightly effervescent (3 percent calcium carbonate); mildly alkaline; abrupt smooth boundary.

Bw1—2 to 9 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/2) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; strongly effervescent (7 percent calcium carbonate); mildly alkaline; clear smooth boundary.

Bw2—9 to 17 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; violently effervescent (11 percent calcium carbonate); mildly alkaline; abrupt smooth boundary.

2Bk1—17 to 23 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; many very fine roots; few very fine tubular pores; many fine irregular lime

accumulations; violently effervescent (25 percent calcium carbonate); mildly alkaline; clear smooth boundary.

2Bk2—23 to 35 inches; white (N 8/0) sandy clay loam, pinkish white (7.5YR 8/2) moist; weak medium subangular blocky structure; very hard, friable, sticky and plastic; few very fine roots; few very fine tubular pores; many fine irregular lime accumulations; violently effervescent (30 percent calcium carbonate); mildly alkaline; abrupt smooth boundary.

3Cr—35 to 60 inches; thinly bedded sandstone and shale; few very fine roots oriented along plates.

The depth to paralithic contact ranges from 24 to 40 inches. The depth to a calcic horizon ranges from 8 to 25 inches. Calcium carbonate equivalent ranges from 15 to 40 percent in the calcic horizon.

Cannonville Series

The Cannonville series consists of very shallow and shallow, well drained, slowly permeable soils on hills. These soils formed in alluvium and residuum derived dominantly from soft shale. Slopes range from 15 to 50 percent. Elevation is 5,700 to 6,300 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

These soils are clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents.

Typical pedon of Cannonville clay loam, 15 to 50 percent slopes, about 3.5 miles southwest of Five Houses; about 3,800 feet south of the northeast corner of sec. 5, T. 28 N., R. 19 E.

A—0 to 2 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; moderate medium platy structure over strong fine granular; slightly hard, friable, sticky and plastic; common very fine roots; few fine vesicular pores; violently effervescent; mildly alkaline; clear smooth boundary.

Bw—2 to 5 inches; yellowish brown (10YR 5/4) clay loam, light olive brown (2.5YR 5/4) moist; weak fine subangular blocky structure; hard, firm, very sticky and very plastic; many very fine roots; few fine tubular pores; violently effervescent; mildly alkaline; clear smooth boundary.

C1—5 to 8 inches; yellowish brown (10YR 5/4) clay, olive brown (2.5YR 4/4) moist; massive; hard, friable, very sticky and very plastic; many very fine roots; no pores; about 20 percent soft shale fragments; violently effervescent; moderately alkaline; abrupt smooth boundary.

C2—8 to 12 inches; variegated light yellowish brown, light brownish gray, and white (10YR 6/4, 6/2, and 8/1) clay loam, brown, dark grayish brown, and very pale brown (10YR 5/3, 4/2, and 8/3) moist; massive; slightly hard, friable, sticky and plastic; many very fine roots; no pores; about 75 percent soft shale fragments; violently effervescent; moderately alkaline; gradual smooth boundary.

2Cr1—12 to 24 inches; weathered shale; seams of gypsum and lime in fractures; gradual smooth boundary.

2Cr2—24 to 75 inches; shale; seams of gypsum and lime in fractures.

The depth to paralithic contact ranges from 7 to 20 inches. The thickness of the solum is less than 10 inches. The Bw horizon is clay or clay loam. The content of soft shale fragments ranges from 15 to 75 percent in the C horizon. Commonly, thin seams of lime and gypsum line fractures and faces of shale fragments in the 2Cr horizon.

Doak Series

The Doak series consists of deep, well drained, moderately slowly permeable soils on fan terraces. These soils formed in eolian deposits and in the underlying alluvium derived dominantly from sandstone and shale. Slopes range from 1 to 3 percent. Elevation is 5,100 to 5,600 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

The Doak soils in this survey area are taxadjuncts because they are calcareous to the surface. This difference, however, does not affect use and management of the soils. These soils are classified as fine-loamy, mixed, mesic Typic Haplargids.

Typical pedon of Doak fine sandy loam, in an area of Doak-Monue complex, 1 to 6 percent slopes, about 1,700 feet north of Dry Dam; about 1,200 feet east and 2,200 feet south of the northwest corner of sec. 16, T. 25 N., R. 27 E.

A—0 to 3 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak medium platy structure over weak fine subangular blocky; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine vesicular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Bw—3 to 15 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine

roots; common very fine tubular pores; slightly effervescent; moderately alkaline; clear smooth boundary.

Btk1—15 to 22 inches; reddish brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common very fine roots; common very fine pores; few faint discontinuous clay films on faces of peds; few fine irregular lime accumulations in pores and root channels; about 2 percent fine pebbles; violently effervescent; moderately alkaline; gradual smooth boundary.

Btk2—22 to 33 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate coarse subangular blocky structure; very hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; common faint discontinuous clay films on faces of peds; common fine lime accumulations in pores and root channels; violently effervescent; moderately alkaline; gradual smooth boundary.

2Bk—33 to 47 inches; light reddish brown (5YR 6/4) fine sandy loam that has few thin strata of gravelly clay, reddish brown (5YR 5/4) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and nonplastic; few very fine roots; common very fine tubular pores; common coarse lime accumulations in pores and root channels; violently effervescent; moderately alkaline; clear smooth boundary.

3Cr1—47 to 53 inches; weathered shale; few fine lime filaments; violently effervescent; abrupt smooth boundary.

3Cr2—53 to 65 inches; weathered shale; few fine lime filaments interbedded with weathered shale; slightly effervescent (violently effervescent in the lime filaments).

The depth to paralithic contact ranges from 40 to 60 inches. The Btk horizon is sandy clay loam or clay loam. Calcium carbonate equivalent is less than 15 percent.

Epikom Series

The Epikom series consists of shallow, well drained, moderately rapidly permeable, sodic soils on the edges of mesas and plateaus. These soils formed in thin eolian deposits over slope alluvium and material weathered from sedimentary rocks. Slopes range from 1 to 5 percent. Elevation is 5,000 to 5,400 feet. The mean annual precipitation is about 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are loamy, mixed, mesic Lithic Camborthids.

Typical pedon of Epikom very gravelly fine sandy loam, 1 to 5 percent slopes, near Monument Point on Garces Mesa; about 400 feet south and 200 feet west of the center of sec. 19, T. 25 N., R. 14 E.

An—0 to 1 inch; reddish brown (5YR 5/4) very gravelly fine sandy loam, reddish brown (5YR 4/4) moist; weak medium platy structure over weak fine granular; soft, very friable, slightly sticky and plastic; many very fine roots; few very fine vesicular pores; about 60 percent subrounded, wind-polished pebbles on the surface; slightly effervescent; moderately alkaline; moderately sodic (SAR 15); abrupt smooth boundary.

Bwn1—1 to 5 inches; yellowish red (5YR 4/6) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; few very fine tubular pores; slightly effervescent; strongly alkaline; slightly sodic (SAR 11); clear smooth boundary.

Bwn2—5 to 13 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; few fine soft lime accumulations; about 3 percent pebbles; violently effervescent; strongly alkaline; slightly sodic (SAR 11); clear smooth boundary.

Bkn—13 to 17 inches; light reddish brown (5YR 6/3) gravelly loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; common very fine tubular pores; common fine soft lime accumulations; about 30 percent pebbles partially coated with lime; violently effervescent; strongly alkaline; slightly sodic (SAR 10); abrupt wavy boundary.

2R—17 inches; sandstone.

The depth to bedrock ranges from 10 to 20 inches. The sodium adsorption ratio ranges from 9 to 15. It is generally highest in the surface layer.

Hano Series

The Hano series consists of deep, well drained, slowly permeable soils on foot slopes of pediments. These soils formed in thin eolian deposits and in the underlying alluvium and residuum derived dominantly from shale and sandstone. Slopes range from 2 to 10 percent. Elevation is 5,700 to 6,100 feet. The mean annual precipitation is 10 to 14 inches, the mean annual

air temperature is 51 to 53 degrees F, and the frost-free period is 130 to 150 days.

These soils are fine, mixed, mesic Ustollic Haplargids.

Typical pedon of Hano fine sandy loam, 2 to 10 percent slopes, about 2.5 miles southwest of Five Houses; about 1,000 feet west and 1,500 feet south of the northeast corner of sec. 5, T. 27 N., R. 19 E.

A—0 to 3 inches; brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 5/4) moist; moderate thin platy structure over weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine vesicular pores; violently effervescent (6 percent calcium carbonate); mildly alkaline; abrupt smooth boundary.

Bt—3 to 8 inches; strong brown (7.5YR 5/6) clay loam, dark brown (7.5YR 4/4) moist, weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; common fine tubular pores; few faint discontinuous clay films on faces of peds; violently effervescent (12 percent calcium carbonate); mildly alkaline; clear wavy boundary.

2Btk1—8 to 12 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 4/4) moist, and light yellowish brown (10YR 6/4) clay, dark yellowish brown (10YR 4/4) moist; weak medium prismatic structure parting to moderate fine subangular blocky; hard, very firm, sticky and plastic; many very fine roots; common fine tubular pores; prominent discontinuous clay films on faces of peds and lining pores; few fine accumulations of lime in pores and on faces of peds; violently effervescent (20 percent calcium carbonate); moderately alkaline; clear wavy boundary.

2Btk2—12 to 22 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 4/4) moist; occurring as tongues between areas of very pale brown (10YR 7/3) clay, light yellowish brown (10YR 6/4) moist; moderate coarse prismatic structure parting to weak medium angular blocky; hard, very firm, sticky and plastic; many very fine roots; common fine tubular pores; about 20 percent soft shale fragments; prominent discontinuous clay films on faces of peds and lining pores; few fine accumulations of lime in pores and on faces of peds; violently effervescent (20 percent calcium carbonate); moderately alkaline; clear irregular boundary.

2C1/Btk3—22 to 31 inches; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist occurring as tongues and thick coatings on faces of peds and in pores; moderate medium prismatic structure; very hard, extremely firm, very sticky and plastic; few very fine roots; few fine tubular pores; few faint discontinuous clay films on faces of peds and lining pores; few fine accumulations of lime in pores; about 30 percent soft shale fragments; violently effervescent; moderately alkaline; clear smooth boundary.

2C2—31 to 42 inches; variegated light yellowish brown (10YR 6/4), light gray (10YR 7/2), and grayish brown (10YR 5/2) clay, yellowish brown (10YR 5/4), light yellowish brown (10YR 6/4), and dark grayish brown (10YR 4/2) moist; massive; vertical desiccation cracks 1 to 4 inches wide; very hard, very firm, very sticky and very plastic; few very fine roots along cracks and fractures; no visible pores; about 75 percent soft shale fragments; violently effervescent; moderately alkaline; clear smooth boundary.

2Cr—42 to 84 inches; fractured shale.

The depth to paralithic contact ranges from 40 to 55 inches. The Bt horizon is clay loam or clay. The C horizon is predominantly clay or silty clay and is 15 to 75 percent soft shale fragments.

Ives Series

The Ives series consists of deep, somewhat excessively drained, moderately permeable, stratified soils on flood plains. These soils formed in alluvium derived dominantly from sandstone and shale. Slopes range from 0 to 2 percent. Elevation is 4,900 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are coarse-loamy, mixed (calcareous), mesic Typic Torrifluvents.

Typical pedon of Ives fine sandy loam, 0 to 2 percent slopes, about 1 mile south-southwest of Lost Gun Point and north of Jeddito Wash; 800 feet west and 2,500 south of the northeast corner of sec. 32, T. 25 N., R. 17 E.

A—0 to 3 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; weak medium platy structure over weak fine subangular blocky; slightly hard, very friable, nonsticky and nonplastic; few fine roots; many very fine tubular pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

C1—3 to 15 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine

pores; slightly effervescent; moderately alkaline; clear smooth boundary.

C2—15 to 35 inches; light yellowish brown (10YR 6/4) fine sandy loam that has thin strata of coarser or finer textures, yellowish brown (10YR 5/4) moist; massive; very hard, friable, slightly sticky and slightly plastic; common fine roots; common very fine tubular pores; light brownish gray (10YR 6/2) silty clay cutans along vertical cracks; yellowish red (5YR 5/8) coatings and masses of iron oxide associated with thin clay stratum at a depth of 22 inches; slightly effervescent; mildly alkaline; gradual smooth boundary.

C3—35 to 50 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; massive; very hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine tubular pores; slightly effervescent; mildly alkaline; gradual smooth boundary.

C4—50 to 66 inches; light yellowish brown (10YR 6/4) fine sandy loam that has few thin discontinuous strata of clay, yellowish brown (10YR 5/4) moist; massive; very hard, friable, slightly sticky and slightly plastic; few fine tubular pores; yellowish red (10YR 5/8) coatings and masses of iron oxide associated with clay strata; slightly effervescent; moderately alkaline; gradual smooth boundary.

C5—66 to 84 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; massive; very hard, friable, slightly sticky and slightly plastic; few very fine roots; no pores; slightly effervescent; moderately alkaline.

The C horizon is sandy loam or fine sandy loam that has discontinuous clay strata ranging from ⅛ inch to 2 inches in thickness.

Jeddito Series

The Jeddito series consists of deep, somewhat excessively drained, moderately rapidly permeable soils on stream terraces and fan terraces. These soils formed in mixed alluvium derived dominantly from sandstone and shale. Slopes range from 0 to 5 percent. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are coarse-loamy, mixed (calcareous), mesic Typic Torriorthents.

Typical pedon of Jeddito loamy sand, 0 to 5 percent slopes, about 2 miles northwest of Egloffstein Butte; 2,200 feet south and 350 feet east of the northwest corner of sec. 8, T. 25 N., R. 18 E.

A—0 to 2 inches; light yellowish brown (10YR 6/4) loamy sand, yellowish brown (10YR 5/4) moist; weak medium platy structure over weak fine subangular blocky; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine vesicular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

C1—2 to 9 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; weak thick platy structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few very fine pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

C2—9 to 13 inches; light yellowish brown (10YR 6/4) loamy sand, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; few very fine tubular pores; slightly effervescent; moderately alkaline; clear wavy boundary.

C3—13 to 27 inches; light yellowish brown (10YR 6/4), stratified sand and coarse sand, yellowish brown (10YR 5/4) moist; massive; loose, nonsticky and nonplastic; common very fine roots; few very fine tubular and irregular pores; clay lenses ½ inch thick; slightly effervescent; moderately alkaline; clear wavy boundary.

C4—27 to 40 inches; light yellowish brown (10YR 6/4) fine sandy loam that has strata of sand and very fine sandy loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine and fine tubular pores; slightly effervescent; moderately alkaline; clear wavy boundary.

C5—40 to 84 inches; light yellowish brown (10YR 6/4) fine sandy loam that has thin strata of finer and coarser textures, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; few fine gypsum crystals and coal fragments; very slightly effervescent; moderately alkaline.

The C horizon is sand, loamy sand, loamy fine sand, or fine sandy loam that has discontinuous lenses of loamy very fine sand, fine sandy loam, very fine sandy loam, silty clay loam, and clay. The lenses vary in thickness and spacing, but thickness ranges from less than ⅛ inch to 4 inches. The control section averages 10 to 15 percent clay.

Jocity Series

The Jocity series consists of deep, well drained, moderately slowly permeable and slowly permeable

soils on flood plains and alluvial fans. These soils formed in alluvium derived dominantly from shale and sandstone. Slopes range from 0 to 3 percent. Elevation is 4,800 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are fine-loamy, mixed (calcareous), mesic Typic Torrifluvents.

Typical pedon of Jocity fine sandy loam, 0 to 3 percent slopes, about 2 miles southeast of Five Houses; 3,500 feet west and 2,000 feet north of the southeast corner of sec. 32, T. 28 N., R. 19 E.

A—0 to 3 inches; yellowish brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; moderate medium platy structure; slightly hard, friable, sticky and plastic; few very fine roots; many very fine vesicular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

C—3 to 8 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate thin platy structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Cy1—8 to 16 inches; yellowish brown (10YR 5/4) sandy clay loam that has thin strata of coarser and finer textures, dark yellowish brown (10YR 4/4) moist; weak medium and coarse subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; few fine soft gypsum accumulations; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Cy2—16 to 34 inches; light yellowish brown (10YR 6/4) sandy clay loam that has thin strata of coarser and finer textures, yellowish brown (10YR 5/4) moist; massive; slightly hard, firm, slightly sticky and plastic; few very fine roots; common very fine tubular pores; few fine soft gypsum accumulations; slightly effervescent; moderately alkaline; clear wavy boundary.

Cy3—34 to 48 inches; yellowish brown (10YR 5/4) clay loam that has thin strata of coarser and finer textures, dark yellowish brown (10YR 4/4) moist; massive; hard, very firm, sticky and very plastic; few very fine roots; few very fine tubular pores; vertical desiccation cracks; few fine soft gypsum accumulations; slightly effervescent; moderately alkaline; abrupt clear boundary.

Cy4—48 to 84 inches; yellowish brown (10YR 5/4) clay loam that has thin strata of coarser and finer textures, dark yellowish brown (10YR 4/4) moist; massive; hard, very firm, sticky and very plastic; few very fine roots; few very fine tubular pores; vertical desiccation cracks; few fine soft gypsum accumulations; slightly effervescent; moderately alkaline.

The A horizon is fine sandy loam or clay loam. The C horizon is commonly sandy clay loam or clay loam, but in some pedons it contains strata of coarser and finer textures. The soils are nonsodic to strongly sodic. The sodium adsorption ratio ranges from less than 1 to 35.

Joraibi Series

The Joraibi series consists of deep, well drained, sodic soils on alluvial fans. These soils are slowly permeable in the upper part and moderately rapidly permeable in the lower part. They formed in mixed alluvium derived dominantly from sandstone and shale. Slopes range from 0 to 2 percent. Elevation is 4,800 to 4,900 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Torrifluvents.

Typical pedon of Joraibi clay loam, 0 to 2 percent slopes, southwest of Garces Mesa; about 0.2 mile north of the southwest corner of sec. 17, T. 25 N., R. 13 E.

An—0 to 2 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 5/4) moist; moderate thin platy structure over weak fine granular; hard, firm, sticky and plastic; few very fine roots; common fine irregular pores; slightly effervescent; moderately alkaline; moderately sodic (SAR 23); abrupt smooth boundary.

Cn1—2 to 5 inches; reddish brown (5YR 5/4) clay loam, yellowish red (5YR 4/6) moist; weak medium platy structure; hard, firm, sticky and plastic; few very fine roots; few fine tubular pores; slightly effervescent; moderately alkaline; moderately sodic (SAR 23); clear smooth boundary.

Cn2—5 to 11 inches; yellowish red (5YR 4/6) sandy clay loam, reddish brown (5YR 4/4) moist; massive with thinly bedded laminae; hard, firm, sticky and plastic; common very fine roots; few fine tubular pores; slightly effervescent; strongly alkaline; moderately sodic (SAR 23); clear smooth boundary.

Cn3—11 to 19 inches; light reddish brown (5YR 6/3) clay loam, reddish brown (5YR 5/4) moist; massive with thinly bedded laminae; very hard, firm, very sticky and plastic; few fine roots; common fine tubular pores; slightly effervescent; strongly alkaline; moderately sodic (SAR 23); abrupt smooth boundary.

Cn4—19 to 23 inches; reddish brown (5YR 5/4) very fine sandy loam, yellowish red (5YR 4/6) moist; massive with thinly bedded laminae; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine tubular pores; slightly effervescent; strongly alkaline; moderately sodic (SAR 23); abrupt smooth boundary.

2Cn5—23 to 26 inches; yellowish red (5YR 5/8) sand, yellowish red (5YR 5/8) moist; massive; hard, very friable, nonsticky and nonplastic; few very fine roots; few fine tubular pores; slightly effervescent; strongly alkaline; strongly sodic (SAR 41); abrupt smooth boundary.

2Cn6—26 to 54 inches; reddish yellow (5YR 6/6) sand that has thin strata of coarse sand, fine sand, and very fine sandy loam, reddish brown (5YR 5/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; few fine tubular pores; slightly effervescent; strongly alkaline; strongly sodic (SAR 41); abrupt smooth boundary.

3Cn7—54 to 84 inches; light reddish brown (5YR 6/4), stratified very fine sandy loam to clay loam, reddish brown (5YR 5/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; very hard, firm, sticky and very plastic; no roots; few fine tubular pores; slightly effervescent; strongly sodic (SAR 25); moderately alkaline.

The depth to contrasting particle size ranges from 16 to 39 inches. The C horizon is very fine sandy loam, sandy clay loam, or clay loam. The 2C horizon is commonly sand, loamy sand, or loamy fine sand. It has thin strata of finer textures in some pedons. The sodium adsorption ratio ranges from 20 to 50.

Kinan Series

The Kinan series consists of deep, somewhat excessively drained, moderately rapidly permeable soils on fan terraces skirting basalt-capped buttes and mesas. These soils formed in eolian deposits and alluvium derived dominantly from sedimentary rocks. Slopes range from 2 to 12 percent. Elevation is 5,500 to 5,900 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are coarse-loamy, mixed, mesic Typic Calciorthids.

Typical pedon of Kinan very gravelly loamy fine sand, in an area of Kinan complex, 2 to 12 percent slopes, on the south side of Egloffstein Butte; about 700 feet west and 1,000 feet north of the southeast corner of sec. 16, T. 25 N., R. 18 E.

A—0 to 1 inch; brown (7.5YR 5/4) very gravelly loamy fine sand, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; about 40 percent subangular basalt pebbles and 10 percent cobbles; strongly effervescent (6 percent calcium carbonate); mildly alkaline; abrupt smooth boundary.

Bk1—1 to 6 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; common very fine tubular pores; about 10 percent subangular basalt pebbles and 3 percent cobbles; few fine irregular lime accumulations in pores and on undersides of rock fragments; strongly effervescent (10 percent calcium carbonate); moderately alkaline; clear smooth boundary.

Bk2—6 to 12 inches; light brown (7.5YR 6/4) fine sandy loam, dark brown (7.5YR 4/4) moist; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; common very fine tubular pores; about 5 percent subangular basalt pebbles and 5 percent cobbles; common fine irregular lime accumulations in pores and on undersides of rock fragments; violently effervescent (14 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bk3—12 to 30 inches; light brown (7.5YR 6/4) gravelly fine sandy loam, light brown (7.5YR 5/4) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; few very fine irregular pores; about 20 percent subangular basalt pebbles and 5 percent cobbles; many coarse irregular lime accumulations in pores and root channels and on undersides of rock fragments; weakly cemented; violently effervescent (25 percent calcium carbonate); moderately alkaline; clear wavy boundary.

2Bk4—30 to 45 inches; pinkish gray (7.5YR 7/2) gravelly fine sand, light brown (7.5YR 6/4) moist; massive; hard, firm, nonsticky and nonplastic; few very fine roots; no pores; about 15 percent subangular basalt pebbles and 5 percent cobbles; many coarse irregular lime accumulations and coatings on rock fragments; violently effervescent (30 percent calcium carbonate); moderately alkaline; clear wavy boundary.

3Bk5—45 to 84 inches; light brown (7.5YR 6/4) sand, brown (7.5YR 5/4) moist; massive; slightly hard, firm, nonsticky and nonplastic; few very fine roots; no pores; about 5 percent subangular basalt pebbles; few fine irregular lime accumulations in pores and root channels and on rock fragments;

violently effervescent (11 percent calcium carbonate); moderately alkaline.

Depth to the calcic horizon ranges from 12 to 20 inches. The content of rock fragments ranges from 5 to 50 percent in any one horizon. Gravel lenses in the soil are discontinuous and highly variable. The A horizon is fine sandy loam or very gravelly loamy fine sand.

Kydestea Series

The Kydestea series consists of very shallow and shallow, well drained, moderately slowly permeable soils on hills. These soils formed in alluvium and colluvium derived dominantly from sedimentary rocks. Slopes range from 5 to 50 percent. Elevation is 5,900 to 6,800 feet. The mean annual precipitation is 12 to more than 14 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

These soils are loamy-skeletal, mixed (calcareous), mesic Lithic Ustorthents.

Typical pedon of Kydestea very channery sandy clay loam, in an area of Kydestea-Zyme-Tonalea complex, 5 to 50 percent slopes, about 2,990 feet west and 2,250 feet north of the intersection of metric coordinates 4016 N. and 521 E.; about 8.0 miles west of Cottonwood Spring and 0.3 mile north of the Black Mesa pipeline:

A—0 to 1 inch; light yellowish brown (10YR 6/4) very channery sandy clay loam, dark brown (10YR 4/3) moist; weak thick platy structure; slightly hard, friable, sticky and slightly plastic; few very fine roots; many very fine vesicular pores; about 55 percent sandstone channers; strongly effervescent; mildly alkaline; clear smooth boundary.

C1—1 to 5 inches; brown (10YR 5/3) very channery sandy clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; about 45 percent sandstone channers and 10 percent flagstones; strongly effervescent; moderately alkaline; clear smooth boundary.

C2—5 to 10 inches; brown (10YR 5/3) extremely channery sandy clay loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; few very fine tubular pores; about 60 percent sandstone channers and 5 percent flagstones; strongly effervescent; moderately alkaline; abrupt smooth boundary.

C3—10 to 15 inches; pale brown (10YR 6/3) extremely channery sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; about 60 percent sandstone channers and 5 percent flagstones; strongly effervescent; moderately alkaline; abrupt smooth boundary.

2R—15 inches; sandstone.

The depth to bedrock ranges from 4 to 19 inches. The content of rock fragments on the surface ranges from 35 to 55 percent. The C horizon is dominantly very channery or extremely channery clay loam or sandy clay loam. Some pedons have a thin Bw horizon.

Mido Series

The Mido series consists of deep, excessively drained, rapidly permeable soils on dunes. These soils formed in eolian deposits derived dominantly from sandstone. Slopes range from 1 to 15 percent. Elevation is 5,800 to 6,600 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

These soils are mixed, mesic Ustic Torripsamments.

Typical pedon of Mido fine sand, 1 to 15 percent slopes, about 4 miles south of Keams Canyon; 3,500 feet north and 3,000 feet west of the southeast corner of sec. 9, T. 28 N., R. 20 E.

A—0 to 3 inches; brown (7.5YR 5/4) fine sand, dark brown (7.5YR 4/4) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common fine roots; few fine vesicular pores; noneffervescent; mildly alkaline; abrupt smooth boundary.

C1—3 to 12 inches; strong brown (7.5YR 5/6) fine sand, strong brown (7.5YR 4/6) moist; weak moderate subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few fine tubular pores; few thin cutans on sand grains; noneffervescent; mildly alkaline; gradual smooth boundary.

C2—12 to 22 inches; strong brown (7.5YR 5/6) fine sand, strong brown (7.5YR 4/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine and few coarse roots; common very fine tubular pores; thin discontinuous strata of sandy loam; slightly effervescent; moderately alkaline; gradual smooth boundary.

C3—22 to 36 inches; strong brown (7.5YR 5/6) fine sand, strong brown (7.5YR 4/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few fine tubular pores; slightly effervescent; moderately alkaline; gradual smooth boundary.

C4—36 to 84 inches; strong brown (7.5YR 5/6) fine

sand, strong brown (7.5YR 4/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few fine tubular pores; slightly effervescent; moderately alkaline.

The A horizon is fine sand or loamy fine sand. The C horizon is loamy sand, fine sand, or loamy fine sand.

Milok Series

The Milok series consists of deep, well drained, moderately rapidly permeable soils on plateaus. These soils formed in eolian deposits and in the underlying alluvium derived dominantly from sandstone and limestone. Slopes range from 1 to 12 percent. Elevation is 6,000 to 6,600 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

These soils are coarse-loamy, mixed, mesic Ustollic Calciorthids.

Typical pedon of Milok fine sandy loam, in an area of Milok-Mido complex, 1 to 12 percent slopes, about 5.5 miles southwest of Keams Canyon; about 2,500 feet north and 650 feet west of the southeast corner of sec. 11, T. 27 N., R. 19 E.

A—0 to 2 inches; strong brown (7.5YR 5/6) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium platy structure; soft, very friable, nonsticky and slightly plastic; common very fine roots; many very fine vesicular pores; about 10 percent limestone pebbles on the surface; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bk1—2 to 5 inches; strong brown (7.5YR 5/6) very fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few coarse roots; common very fine tubular pores; about 10 percent pebbles; few fine lime accumulations in pores; violently effervescent; moderately alkaline; clear smooth boundary.

Bk2—5 to 9 inches; brown (7.5YR 5/4) gravelly very fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; about 20 percent lime-coated pebbles and 5 percent lime-coated cobbles; few fine lime accumulations in pores; violently effervescent (4 percent calcium carbonate); moderately alkaline; clear smooth boundary.

Bk3—9 to 15 inches; pink and light brown (7.5YR 7/4 and 6/4) very fine sandy loam, brown (7.5YR 5/4) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; common medium irregular lime accumulations; violently effervescent (20 percent calcium carbonate); moderately alkaline; gradual smooth boundary.

2Bk4—15 to 35 inches; pinkish white (7.5YR 8/2) sandy loam, pinkish gray (7.5YR 6/2) moist; massive; hard, friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; many medium and large irregular lime accumulations; violently effervescent (20 percent calcium carbonate); moderately alkaline; clear smooth boundary.

2C—35 to 55 inches; banded white and pinkish white (7.5YR and N 8/0 and 8/2) fine sand, very pale brown and yellowish brown (10YR 7/3 and 5/4) moist; massive; hard, friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; slightly effervescent (9 percent calcium carbonate); moderately alkaline; clear wavy boundary.

3Cr—55 inches; sandstone.

The depth to paralithic contact ranges from 40 to 60 inches. Depth to the calcic horizon ranges from 8 to 18 inches. Calcium carbonate equivalent is 15 to 40 percent in the calcic horizon.

Monue Series

The Monue series consists of deep, well drained, moderately rapidly permeable soils on plateaus and fan terraces. These soils formed in loamy eolian deposits. Slopes range from 1 to 8 percent. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are coarse-loamy, mixed, mesic Typic Camborthids.

Typical pedon of Monue very fine sandy loam, 1 to 5 percent slopes, about 6.5 miles northwest of Rough Rock Point; 1,100 feet east and 700 feet north of the southwest corner of sec. 17, T. 31 N., R. 14 E.

A—0 to 1 inch; reddish brown (5YR 4/4) very fine sandy loam, dark reddish brown (5YR 3/4) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; slightly effervescent; moderately alkaline; clear smooth boundary.

Bw1—1 to 7 inches; reddish brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; common very fine tubular pores; slightly

effervescent; moderately alkaline; clear smooth boundary.

Bw2—7 to 15 inches; reddish brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; about 2 percent pebbles; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk1—15 to 29 inches; strong brown (7.5YR 5/6) fine sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few fine lime accumulations in pores; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk2—29 to 46 inches; pink (7.5YR 7/4) fine sandy loam, light brown (7.5YR 6/4) moist; weak medium subangular blocky structure; hard, friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; common fine lime accumulations in pores; strongly effervescent; moderately alkaline; clear smooth boundary.

2BCk—46 to 84 inches; very pale brown (10YR 7/3) loamy fine sand, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; no pores; few fine irregular lime accumulations; strongly effervescent; moderately alkaline.

The A horizon is fine sandy loam or very fine sandy loam. The B horizon also is fine sandy loam or very fine sandy loam. The sodium adsorption ratio is more than 10 below a depth of 40 inches in some pedons. Calcium carbonate equivalent is less than 5 percent.

Naha Series

The Naha series consists of deep, well drained soils on stream terraces. These soils are rapidly permeable in the upper part and slowly permeable in the lower part. They formed in moderately thick, sandy alluvium over stratified loamy alluvium derived dominantly from sandstone and shale. Slopes range from 0 to 3 percent. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are sandy over loamy, mixed (calcareous), mesic Typic Torriorthents.

Typical pedon of Naha loamy sand, 0 to 3 percent slopes, about 1.5 miles northwest of Egloffstein Butte; about 1,100 feet east and 400 feet north of the southwest corner of sec. 5, T. 25 N., R. 18 E.

A1—0 to 2 inches; light yellowish brown (10YR 6/4) loamy sand, yellowish brown (10YR 5/4) moist; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine vesicular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

A2—2 to 14 inches; light yellowish brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine tubular pores; discontinuous laminated clay layer at a depth of 12 inches with few fine lime accumulations; slightly effervescent; mildly alkaline; clear smooth boundary.

Bw1—14 to 21 inches; yellowish brown (10YR 5/4) loamy sand, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine tubular pores; slightly effervescent; mildly alkaline; clear smooth boundary.

Bw2—21 to 27 inches; light yellowish brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; few very fine tubular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

2C1—27 to 58 inches; pale brown (10YR 6/3) and dark grayish brown (10YR 4/2), stratified loamy sand to clay, brown (10YR 4/3) and dark yellowish brown (10YR 3/4) moist; massive; hard, firm, sticky and plastic in the clay layers; common very fine roots; common very fine tubular pores; few fine distinct strong brown (7.5YR 5/6) mottles in the clay layers; strongly effervescent; mildly alkaline; abrupt smooth boundary.

3C2—58 to 84 inches; light yellowish brown (10YR 6/4) sandy loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; no roots; common very fine tubular pores; strongly effervescent; mildly alkaline.

The depth to contrasting stratified loamy material ranges from 20 to 40 inches. The 2C horizon is highly stratified. Dominant textures are clay loam or loam, but individual strata range from loamy sand to clay.

Nakai Series

The Nakai series consists of deep, well drained, moderately permeable soils on fan terraces and plateaus. These soils formed in eolian deposits and in the underlying alluvium derived dominantly from sandstone and shale. Slopes range from 1 to 15

percent. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are coarse-loamy, mixed, mesic Typic Calciorthids.

Typical pedon of Nakai very fine sandy loam, in an area of Nakai-Monue very fine sandy loams, 1 to 5 percent slopes, about 2.5 miles northwest of Lost Gun Point; 1,500 feet west and 2,200 feet south of the northeast corner of sec. 8, T. 25 N., R. 17 E.

A—0 to 3 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak medium platy structure over weak fine subangular blocky; soft, very friable, nonsticky and slightly plastic; few very fine roots; few very fine irregular pores; very slightly effervescent (2 percent calcium carbonate); moderately alkaline; abrupt smooth boundary.

Bk1—3 to 10 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 5/6) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; few very fine tubular pores; few fine irregular lime accumulations; slightly effervescent (3 percent calcium carbonate); moderately alkaline; clear smooth boundary.

Bk2—10 to 17 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; few fine lime accumulations; slightly effervescent (6 percent calcium carbonate); strongly alkaline; clear smooth boundary.

Bk3—17 to 24 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; few fine lime accumulations; few silt cutans on faces of peds; strongly effervescent (5 percent calcium carbonate); strongly alkaline; clear smooth boundary.

Bk4—24 to 30 inches; brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 4/4) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; few very fine tubular pores; few fine lime accumulations; common silt cutans on faces of peds; strongly effervescent (9 percent calcium carbonate); strongly alkaline; clear smooth boundary.

2Bk5—30 to 35 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; no visible pores; common silt cutans on faces of peds; many fine irregular lime accumulations; violently effervescent (20 percent calcium carbonate); strongly alkaline; gradual wavy boundary.

2Bk6—35 to 48 inches; pinkish white (7.5YR 8/2) sandy clay loam, pinkish gray (7.5YR 7/2) moist; weak medium subangular blocky structure; very hard, firm, very sticky and very plastic; few very fine roots; no visible pores; many fine and medium irregular lime accumulations; violently effervescent (45 percent calcium carbonate); strongly alkaline; gradual wavy boundary.

2Bk7—48 to 84 inches; light brown (7.5YR 6/4) and pinkish white (7.5YR 8/2) sandy clay loam, brown (7.5YR 5/4) and pinkish gray (7.5YR 7/2) moist; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; no roots; no visible pores; many fine and medium irregular lime accumulations; violently effervescent (40 percent calcium carbonate); strongly alkaline.

Depth to the calcic horizon ranges from 20 to 35 inches. The sodium adsorption ratio is more than 15 below a depth of 40 inches in some pedons. Some pedons have sand textures in the lower part of the particle-size control section and have bedrock at a depth of 40 to 60 inches.

The A horizon is fine sandy loam or very fine sandy loam. The B horizon is fine sandy loam or very fine sandy loam. The 2B horizon is sandy clay loam, but when the clay-sized carbonates are subtracted the particle-size control section is coarse-loamy.

Penistaja Series

The Penistaja series consists of deep, well drained, moderately permeable soils on plateaus. These soils formed in eolian deposits and alluvium derived dominantly from sandstone. Slopes range from 1 to 8 percent. Elevation is 5,900 to 6,800 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

These soils are fine-loamy, mixed, mesic Ustollic Haplargids.

Typical pedon of Penistaja fine sandy loam, in an area of Penistaja-Begay complex, 1 to 8 percent slopes, about 2.5 miles northeast of Keams Canyon; in an unsurveyed area interpolated to be 1,250 feet east and 1,350 feet south of the northwest corner of sec. 13, T. 28 N., R. 20 E.

A—0 to 2 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak thin platy structure over weak fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; noneffervescent; mildly alkaline; abrupt smooth boundary.

Bt1—2 to 6 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and plastic; many very fine roots; many very fine irregular pores; few faint clay films lining pores; noneffervescent; mildly alkaline; clear smooth boundary.

Bt2—6 to 12 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; few faint clay bridges on sand grains; noneffervescent; mildly alkaline; clear smooth boundary.

Btk1—12 to 18 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; few faint clay films on faces of peds; few fine lime accumulations in pores; slightly effervescent; mildly alkaline; clear smooth boundary.

Btk2—18 to 24 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and slightly plastic; common very fine roots; common very fine tubular pores; few faint clay bridges on sand grains; common fine irregular lime masses; slightly effervescent; mildly alkaline; clear smooth boundary.

Bk1—24 to 38 inches; brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; very hard, firm, sticky and slightly plastic; common very fine roots; common very fine tubular pores; common fine lime accumulations in pores; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk2—38 to 58 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; very hard, firm, slightly sticky and plastic; few very fine roots; common very fine tubular pores; common fine lime accumulations in pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

2Bk3—58 to 84 inches; light yellowish brown (10YR 6/4) gravelly loamy sand, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; no visible pores; common fine lime accumulations; slightly effervescent; mildly alkaline.

The Bt horizon is sandy clay loam or fine sandy loam. The sodium adsorption ratio is as high as 5 below a depth of 50 inches.

Polacca Series

The Polacca series consists of deep, well drained soils on stream terraces. These soils are slowly permeable in the upper part and rapidly permeable in the lower part. They formed in alluvium derived dominantly from sandstone and shale. Slopes range from 0 to 3 percent. Elevation is 5,100 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Camborthids.

Typical pedon of Polacca clay loam, 0 to 3 percent slopes, about 1.5 miles west of Elbow Point; about 2,800 feet west and 500 feet north of the southeast corner of sec. 8, T. 25 N., R. 16 E.

A1—0 to 3 inches; pale brown (10YR 6/3) clay loam, yellowish brown (10YR 5/4) moist; moderate medium platy structure; soft, very friable, sticky and plastic; common very fine roots; many very fine vesicular pores; strongly effervescent; moderately alkaline; abrupt smooth boundary.

A2—3 to 9 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; weak medium platy structure; hard, firm, very sticky and very plastic; common very fine roots; few very fine tubular pores; few very fine lime accumulations between plates; strongly effervescent; moderately alkaline; abrupt smooth boundary.

A3—9 to 14 inches; light yellowish brown (10YR 6/4), stratified very fine sandy loam and silt loam, yellowish brown (10YR 5/4) moist; moderate medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bw—14 to 26 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, very sticky and very plastic; many very fine roots; many

very fine tubular pores; few cutans of silt and organic matter on faces of peds; strongly effervescent; moderately alkaline; abrupt smooth boundary.

2Bk—26 to 33 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; few fine irregular accumulations of lime in root channels; organic coatings on faces of peds; strongly effervescent; moderately alkaline; abrupt smooth boundary.

3C—33 to 84 inches; light yellowish brown (10YR 6/4) loamy sand that has few thin strata of very fine sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; slightly effervescent; moderately alkaline.

The depth to contrasting particle size ranges from 20 to 39 inches. The B horizon is sandy clay loam, clay loam, or clay. The C horizon is sand or loamy sand.

Querencia Series

The Querencia series consists of deep, well drained, moderately permeable soils on stream terraces. These soils formed in mixed alluvium derived dominantly from sandstone and shale. Slopes range from 0 to 3 percent. Elevation is 6,200 to 6,500 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

These soils are fine-loamy, mixed, mesic Ustollic Camborthids.

Typical pedon of Querencia clay loam, 0 to 3 percent slopes, about 1,100 feet east and 600 feet north of the intersection of metric coordinates 4006 N. and 551 E.; about 4.5 miles northeast of Big Mountain Dam:

A—0 to 1 inch; pale brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; weak thin platy structure over weak fine granular; soft, very friable, sticky and plastic; many very fine roots; many very fine tubular pores; slightly effervescent; mildly alkaline; clear smooth boundary.

Bw1—1 to 7 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; faint discontinuous iron oxide stains on faces of peds; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Bw2—7 to 12 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; faint discontinuous iron oxide stains on faces of peds; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Bw3—12 to 33 inches; light yellowish brown (10YR 6/4) sandy clay loam that has thin strata of clay loam and very fine sandy loam, yellowish brown (10YR 5/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; faint discontinuous iron oxide stains on faces of peds; slightly effervescent; moderately alkaline; abrupt smooth boundary.

2Bk1—33 to 46 inches; pale brown (10YR 6/3) fine sandy loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine roots; common very fine tubular pores; few fine irregular lime accumulations in pores and root channels; slightly effervescent; mildly alkaline; abrupt smooth boundary.

2Bk2—46 to 84 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; few fine irregular lime accumulations in pores; slightly effervescent; mildly alkaline.

The B horizon is clay loam, sandy clay loam, or loam. Calcium carbonate equivalent is less than 10 percent. It increases with increasing depth.

Sheppard Series

The Sheppard series consists of deep, somewhat excessively drained, rapidly permeable soils on dunes. These soils formed in eolian deposits derived dominantly from sandstone. Slopes range from 1 to 15 percent. Elevation is 4,800 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are mixed, mesic Typic Torripsamments.

Typical pedon of Sheppard loamy sand, 1 to 15 percent slopes, about 2 miles southwest of Elbow Point; 2,500 feet east and 200 feet north of the southwest corner of sec. 17, T. 25 N., R. 16 E.

A—0 to 2 inches; yellowish red (5YR 5/6) loamy sand, yellowish red (5YR 4/6) moist; very weak medium

platy structure; loose, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; slightly effervescent; mildly alkaline; clear smooth boundary.

C1—2 to 6 inches; yellowish red (5YR 5/6) fine sand, yellowish red (5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; few very fine tubular pores; slightly effervescent; mildly alkaline; clear smooth boundary.

C2—6 to 12 inches; yellowish red (5YR 5/6) fine sand, yellowish red (5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; slightly effervescent; mildly alkaline; clear smooth boundary.

C3—12 to 22 inches; yellowish red (5YR 5/6) fine sand, yellowish red (5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; slightly effervescent; moderately alkaline; gradual smooth boundary.

C4—22 to 36 inches; yellowish red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

C5—36 to 84 inches; yellowish red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; strongly effervescent; moderately alkaline.

The A horizon is sand or loamy sand. The C horizon is sand, fine sand, loamy sand, or loamy fine sand. The soils typically are nonsodic. In sodic pedons, permeability ranges to moderately rapid.

Sheppard sand, 1 to 12 percent slopes, is noneffervescent and yellower than is defined as the range for the series. These differences, however, do not affect use and management of the soil. This soil is typically nonsodic, but if the sodium adsorption ratio is more than 10, range management requirements change and a sodic phase is recognized.

Strych Series

The Strych series consists of deep, well drained, moderately rapidly permeable soils on hills of basalt-capped mesas and buttes. These soils formed in eolian deposits and colluvium derived from sedimentary rocks. Slopes range from 25 to 60 percent. Elevation is 5,800 to 6,700 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 130 to 150 days.

These soils are loamy-skeletal, mixed, mesic Ustollic Calciorthids.

Typical pedon of Strych extremely cobbly fine sandy loam, in an area of Strych-Rock outcrop complex, 25 to 60 percent slopes, 1,400 feet west and 1,750 feet south of the northeast corner of sec. 17, T. 25 N., R. 19 E.; on the southwest slope of Horse Butte:

A—0 to 2 inches; brown (7.5YR 4/4) extremely cobbly fine sandy loam, dark brown (7.5YR 3/4) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; many very fine irregular pores; about 55 percent basalt cobbles and 10 percent pebbles; strongly effervescent (8 percent calcium carbonate); mildly alkaline; abrupt wavy boundary.

Bk1—2 to 9 inches; brown (7.5YR 4/4) very gravelly loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; about 30 percent basalt pebbles and 10 percent cobbles; few fine irregular lime accumulations and coatings on undersides of rock fragments; violently effervescent (12 percent calcium carbonate); moderately alkaline; clear wavy boundary.

Bk2—9 to 23 inches; brown (7.5YR 5/4) very stony fine sandy loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; about 30 percent basalt stones, 20 percent cobbles, and 10 percent pebbles; few fine irregular lime accumulations and coatings on rock fragments; violently effervescent (14 percent calcium carbonate); moderately alkaline; gradual wavy boundary.

Bk3—23 to 60 inches; strong brown (7.5YR 4/6) extremely stony fine sandy loam, strong brown (7.5YR 3/6) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; common very fine roots; few very fine tubular pores; about 40 percent basalt stones, 15 percent cobbles, and 10 percent pebbles; common fine irregular lime accumulations and coatings on rock fragments; violently effervescent (25 percent calcium carbonate); strongly alkaline.

Depth to the calcic horizon ranges from 15 to 30 inches. The content of rock fragments ranges from 40 to 65 percent in the particle-size control section. The fragments increase in size with increasing depth.

Tewa Series

The Tewa series consists of deep, well drained, moderately slowly permeable soils on stream terraces. These soils formed in mixed alluvium derived dominantly from sandstone and shale. Slopes range from 1 to 5 percent. Elevation is 4,900 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are fine-loamy, mixed, mesic Typic Camborthids.

Typical pedon of Tewa very fine sandy loam, 1 to 5 percent slopes, about 3 miles southeast of Five Houses; 1,700 feet north and 500 feet east of the southwest corner of sec. 33, T. 28 N., R. 19 E.

A—0 to 1 inch; light yellowish brown (10YR 6/4) very fine sandy loam, yellowish brown (10YR 5/4) moist; weak medium platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; common very fine vesicular pores; slightly plastic; many very fine roots; common very fine vesicular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

AB—1 to 3 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; weak thin platy structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

By1—3 to 7 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; many very fine roots; common very fine tubular pores; few fine soft gypsum accumulations; slightly effervescent; moderately alkaline; clear smooth boundary.

By2—7 to 17 inches; yellowish brown (10YR 5/4) clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and very plastic; many very fine roots; common very fine tubular pores; few fine soft gypsum accumulations; slightly effervescent; moderately alkaline; clear smooth boundary.

By3—17 to 25 inches; yellowish brown (10YR 5/4) clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; few fine soft gypsum accumulations; strongly effervescent; moderately alkaline; abrupt smooth boundary.

2By4—25 to 31 inches; brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; few fine gypsum accumulations; slightly effervescent; moderately alkaline; clear smooth boundary.

2By5—31 to 43 inches; brown (7.5YR 5/4) and yellowish brown (10YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) and dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; few faint discontinuous cutans on faces of peds; few fine gypsum accumulations; slightly effervescent; moderately alkaline; clear smooth boundary.

2Bw—43 to 84 inches; brown (10YR 5/3) sandy clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine roots; common very fine tubular pores; strongly effervescent; moderately alkaline.

The B horizon is fine sandy loam, sandy clay loam, or clay loam, but it averages 25 to 35 percent clay in the particle-size control section. The content of gypsum is less than 5 percent. Calcium carbonate equivalent is less than 15 percent.

Tonalea Series

The Tonalea series consists of moderately deep, excessively drained, rapidly permeable soils on dunes. These soils formed in eolian deposits derived dominantly from sandstone. Slopes range from 5 to 20 percent. Elevation is 5,900 to 6,800 feet. The mean annual precipitation is 12 to more than 14 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

These soils are mixed, mesic Typic Ustipsamments.

Typical pedon of Tonalea loamy fine sand, in an area of Kydestea-Zyme-Tonalea complex, 5 to 50 percent slopes, about 3,600 feet west and 2,400 feet north of the intersection of metric coordinates 4016 N. and 521 E.; about 8.0 miles west of Cottonwood Spring and 0.3 mile north of the Black Mesa pipeline:

A—0 to 3 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and

nonplastic; many very fine roots; many very fine irregular pores; noneffervescent; mildly alkaline; clear smooth boundary.

C1—3 to 11 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and few coarse roots; many very fine tubular pores; noneffervescent; mildly alkaline; gradual smooth boundary.

C2—11 to 24 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; few fine tubular pores; slightly effervescent; moderately alkaline; clear smooth boundary.

2Cr—24 to 26 inches; weathered sandstone.

2R—26 inches; sandstone.

The depth to bedrock ranges from 20 to 39 inches. The C horizon is sand, loamy sand, or loamy fine sand.

Torrifluvents

Torrifluvents are deep, somewhat poorly drained to well drained soils on bars and channels of flood plains. These soils formed in alluvium derived dominantly from sandstone and shale. Slopes range from 0 to 2 percent. Elevation is 4,900 to 6,000 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

Reference pedon of Torrifluvents, in an area of Torrifluvents, 0 to 2 percent slopes, about 9 miles southwest of Oraibi in Oraibi Wash; in the NW¼ of sec. 7, T. 27 N., R. 16 E.

C1—0 to 1 inch; pale brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) moist; weak medium platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine vesicular pores; strongly effervescent; mildly alkaline; abrupt smooth boundary.

C2—1 to 6 inches; light yellowish brown (10YR 6/4) fine sand, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine irregular pores; strongly effervescent; mildly alkaline; abrupt smooth boundary.

C3—6 to 12 inches; finely stratified, light yellowish brown (10YR 6/4) and dark grayish brown (10YR 4/2) fine sandy loam and loamy fine sand, yellowish brown (10YR 5/4) and very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; common very fine irregular pores; about 5 percent fine subrounded pebbles; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Cy—12 to 41 inches; very pale brown (10YR 7/3) clay that has thin discontinuous sand and gravel lenses, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; many very fine roots; few very fine tubular pores; about 10 percent rounded pebbles of mixed mineralogy and angular fragments of shale; few fine soft accumulations of gypsum in discontinuous pockets; strongly effervescent with violently effervescent pockets; moderately alkaline; abrupt smooth boundary.

C′—41 to 60 inches; light yellowish brown (10YR 6/4) gravelly sandy loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; few very fine tubular pores; about 15 percent pebbles; strongly effervescent; moderately alkaline.

Torrifluvents are variable in texture and color. They are finely stratified.

Torriorthents

Torriorthents are well drained soils on hills. These soils formed in alluvium and colluvium derived dominantly from soft sedimentary rock. Slopes range from 1 to 60 percent. Elevation is 4,800 to 6,800 feet. The mean annual precipitation is 6 to 12 inches, the mean annual air temperature is 51 to 54 degrees F, and the frost-free period is 130 to 160 days.

Reference pedon of Torriorthents, in an area of Typic Torriorthents, 10 to 35 percent slopes, about 2 miles southwest of Seed Hill; about 1,600 feet east and 300 feet north of the southwest corner of sec. 9, T. 25 N., R. 17 E.

A—0 to 2 inches; reddish brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) moist; weak thin platy structure; hard, firm, sticky and plastic; few very fine roots; few very fine vesicular pores; violently effervescent; moderately alkaline; clear smooth boundary.

C1—2 to 22 inches; reddish brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) moist; massive; hard, firm, sticky and very plastic; few very fine roots; few very fine tubular pores; violently effervescent; moderately alkaline; clear smooth boundary.

2C2—22 to 31 inches; light reddish brown (5YR 6/4) fine sandy loam, reddish brown (5YR 5/4) moist;

massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; few fine tubular pores; strongly effervescent; moderately alkaline; clear smooth boundary.

2Cr—31 inches; weathered sandstone.

Torriorthents are variable in depth to sedimentary bedrock and in soil thickness, color, and texture.

Travessilla Series

The Travessilla series consists of very shallow and shallow, well drained, moderately rapidly permeable soils on plateaus and mesas. These soils formed in eolian deposits derived dominantly from sandstone. Slopes range from 1 to 8 percent. Elevation is 5,900 to 6,700 feet. The mean annual precipitation is 10 to 14 inches, the mean annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

These soils are loamy, mixed (calcareous), mesic Lithic Ustic Torriorthents.

Typical pedon of Travessilla very fine sandy loam, in an area of Travessilla-Rock outcrop complex, 1 to 8 percent slopes, about 7 miles northeast of Keams Canyon; in an unsurveyed area interpolated to be 2,500 feet west and 1,900 feet south of the northeast corner of sec. 24, T. 29 N., R. 20 E.

A—0 to 1 inch; brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium platy structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine vesicular pores; slightly effervescent; mildly alkaline; clear smooth boundary.

Bw—1 to 7 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many fine roots; common fine tubular pores; strongly effervescent; moderately alkaline; clear smooth boundary.

C—7 to 11 inches; brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and slightly plastic; common very fine roots; few fine tubular pores; about 10 percent sandstone pebbles; violently effervescent; mildly alkaline; abrupt smooth boundary.

2R—11 inches; sandstone.

The depth to bedrock is 6 to 17 inches. The Bw horizon is gravelly fine sandy loam or fine sandy loam, and the base is at a depth of less than 10 inches. The C horizon is fine sandy loam or very fine sandy loam and has 5 to 15 percent pebbles.

Uzona Series

The Uzona series consists of deep, well drained, very slowly permeable, saline-sodic soils on stream terraces. These soils formed in alluvium derived dominantly from shale and sandstone. Slopes range from 0 to 2 percent. Elevation is 5,200 to 5,400 feet. The mean annual precipitation is 6 to 8 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are fine, montmorillonitic, mesic Typic Natragids.

Typical pedon of Uzona loam, 0 to 2 percent slopes, about 600 feet east of Little Burro Springs; about 1,000 feet east and 1,000 feet south of the northwest corner of sec. 7, T. 26 N., R. 17 E.

Anz—0 to 1 inch; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; moderate thick platy structure over strong fine granular; slightly hard, friable, sticky and plastic; few very fine roots; many fine vesicular pores below a surface crust 0.5 centimeter thick; strongly effervescent; mildly alkaline; moderately saline and strongly sodic (SAR 32); abrupt smooth boundary.

BAnz—1 to 5 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure parting to moderate fine subangular blocky; hard, firm, sticky and plastic; common fine roots; common very fine tubular pores; violently effervescent; moderately alkaline; strongly saline and strongly sodic (SAR 120); clear smooth boundary.

Btnz1—5 to 14 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; moderate coarse prismatic structure; very hard, very firm, very sticky and very plastic; many fine roots; common very fine tubular pores; few faint clay films lining pores; violently effervescent; strongly alkaline; strongly saline and strongly sodic (SAR 237); clear smooth boundary.

Btnz2—14 to 32 inches; light brown (7.5YR 6/4) clay, dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine tubular pores; salt coatings on exposed surfaces; few faint clay films lining pores; violently effervescent; strongly alkaline; strongly saline and strongly sodic (SAR 310); clear smooth boundary.

2Cnz1—32 to 45 inches; light yellowish brown (10YR 6/4) sandy clay, dark yellowish brown (10YR 4/4) moist; massive; very hard, firm, sticky and plastic; few very fine roots; few very fine tubular pores; salt coatings on exposed surfaces; violently

effervescent; strongly alkaline; strongly saline and strongly sodic (SAR 382); clear smooth boundary.

2Cnz2—45 to 58 inches; light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine roots; no visible pores; violently effervescent; very strongly alkaline; strongly saline and strongly sodic; abrupt smooth boundary.

3Cnz3—58 to 84 inches; very pale brown (10YR 7/3) fine sand, light yellowish brown (10YR 6/4) moist; single grain; loose, nonsticky and nonplastic; no roots; no visible pores; violently effervescent; very strongly alkaline; strongly saline and strongly sodic.

The C horizon is sandy clay, clay, or sandy clay loam to a depth of about 58 inches. Below this depth it is commonly fine sand or loamy fine sand, but some pedons contain strata of finer textures. Electrical conductivity averages more than 50 millimhos per centimeter, and the sodium adsorption ratio is more than 200 in the control section.

Wepo Series

The Wepo series consists of deep, well drained, slowly permeable soils on stream terraces. These soils formed in mixed alluvium derived dominantly from shale and sandstone. Slopes range from 0 to 3 percent. Elevation is 5,100 to 6,100 feet. The mean annual precipitation is 6 to 10 inches, the mean annual air temperature is 52 to 54 degrees F, and the frost-free period is 130 to 160 days.

These soils are fine, mixed, mesic Vertic Camborthids.

Typical pedon of Wepo clay loam, 0 to 3 percent slopes, about 1.7 miles west of Elbow Point; 1,200 feet east and 1,600 feet north of the southwest corner of sec. 8, T. 25 N., R. 16 E.

A—0 to 3 inches; pale brown (10YR 6/3) clay loam, yellowish brown (10YR 5/4) moist; strong thick platy structure over strong fine granular; soft, friable, sticky and plastic; few very fine roots; many very fine vesicular pores; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bw1—3 to 11 inches; pale brown (10YR 6/3) clay loam, yellowish brown (10YR 5/4) moist; moderate fine subangular blocky structure; slightly hard, firm, very sticky and plastic; few very fine roots; many very fine tubular pores; strongly effervescent; moderately alkaline; clear smooth boundary.

Bw2—11 to 18 inches; pale brown (10YR 6/3) clay, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; hard, very firm, very sticky and very plastic; many very fine roots; common very fine tubular pores; strongly effervescent; mildly alkaline; clear smooth boundary.

Bk1—18 to 26 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; hard, firm, sticky and very plastic; common very fine roots; common fine tubular pores; few fine irregular lime accumulations; strongly effervescent; mildly alkaline; abrupt smooth boundary.

Bk2—26 to 32 inches; pale brown (10YR 6/3) clay that has strata of sandy loam and silt loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; common very fine irregular pores; few fine irregular lime accumulations; strongly effervescent; mildly alkaline; abrupt smooth boundary.

2C1—32 to 36 inches; light yellowish brown (10YR 6/4) very fine sandy loam that has strata of clay and silt loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine irregular and vesicular pores; strongly effervescent; mildly alkaline; abrupt smooth boundary.

3C2—36 to 43 inches; pale brown (10YR 6/3) clay that has strata of very fine sandy loam, silt loam, and loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; few fine vesicular pores; strongly effervescent; mildly alkaline; abrupt smooth boundary.

4C3—43 to 84 inches; light yellowish brown (10YR 6/4), stratified very fine sandy loam, clay, silt loam, and sand, brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; few fine roots; few very fine and fine tubular pores; strongly effervescent; mildly alkaline.

The B horizon is clay loam or clay that has few strata of coarser textures. The C horizon is stratified with textures ranging from sand to clay, but the particle-size control section averages 35 to 45 percent clay.

Zyme Series

The Zyme series consists of very shallow and shallow, well drained, slowly permeable soils on hills. These soils formed in alluvium and residuum derived dominantly from shale. Slopes range from 5 to 50 percent. Elevation is 5,900 to 6,800 feet. The mean annual precipitation is 10 to 14 inches, the mean annual

air temperature is 50 to 52 degrees F, and the frost-free period is 120 to 150 days.

These soils are clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents.

Typical pedon of Zyme clay loam, in an area of Kydestea-Zyme-Tonalea complex, 5 to 50 percent slopes, on the John Daw Quad, 500 feet east of the intersection of coordinates 4018 N. and 521 E.; about 8.0 miles west of Cottonwood Spring and 0.7 mile north of the Black Mesa pipeline:

A—0 to 1 inch; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate fine granular structure; slightly hard, firm, sticky and very plastic; few very fine roots; many very fine vesicular pores; slightly effervescent; moderately alkaline; clear smooth boundary.

Bw1—1 to 4 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; hard, very firm, very sticky and very plastic; few very fine roots; few very fine tubular pores; slightly effervescent; moderately alkaline; clear smooth boundary.

Bw2—4 to 9 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; very hard, very firm, very sticky and very plastic; common very fine roots; few very fine tubular pores; slightly effervescent; moderately alkaline; gradual smooth boundary.

C—9 to 18 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; massive; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine tubular pores; about 20 percent soft shale fragments; fine soft lime accumulations; mildly alkaline; abrupt smooth boundary.

Cr1—18 to 24 inches; shale; rocklike structure; few fine roots along seams; abrupt smooth boundary.

Cr2—24 inches; shale; common gypsum crystals.

The depth to paralithic contact is 6 to 20 inches. The Bw and C horizons are clay loam or clay. The base of the Bw horizon is at a depth of less than 10 inches. Commonly, thin seams of lime and gypsum line fractures and faces of shale fragments.

Formation of the Soils

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic activities. The characteristics of a soil at any given point depend on the type and mineralogical composition of the parent material; the climate under which the soil material accumulated and has existed since accumulation; the plant and animal life in or on the soil; the relief, or lay of the land; and the length of time these forces have acted upon the soil material *(20)*.

The balance among these soil-forming factors may stabilize over short or long periods of time. If the balance changes, soil properties can also change. During the past million years or so, the soils have undergone dynamic alterations. Streams have eroded the earth's surface and transported sediments to lower areas, eolian materials have been deposited, and the climate and kinds of living organisms have changed.

Geologic History

The survey area lies mainly on and below the southern escarpment and western parts of Black Mesa, a highland area within the south-central part of the Colorado Plateau physiographic province.

The Colorado Plateau is one of 12 major geologic provinces in the United States. It covers about 130,000 square miles of Utah, Arizona, New Mexico, and Colorado. The area is underlain by nearly horizontal sedimentary rocks of the Cambrian to Tertiary periods (approximately 50 to 550 million years old). During these time periods, the Colorado Plateau was part of a shelf area bordering inland seas. Many advances and retreats of the water left deposits of sand, silt, lime, and clay that in time became the formations underlying the survey area. The older deposits are visible today in the Grand Canyon, occurring as the Tapeats Sandstone upward to the Kaibab Limestone *(9)*.

Most of the visible outcrops in the survey area are from the Mesozoic era or younger (less than 200 million years old) and are covered by a mantle of recent alluvium, colluvium, and eolian deposits. These younger sedimentary rocks have eroded in the Grand Canyon area but are partly preserved on Black Mesa and in the surrounding area. These rocks are the Glen Canyon Group, San Rafael Group, Cow Springs Sandstone, Morrison Formation, Dakota Sandstone, Mancos Shale, and Mesa Verde Formation *(21)*.

During the Laramide Orogeny, about 65 million years ago, the entire Colorado Plateau was uplifted without significant deformation. This event caused the final withdrawal of the inland seas. Faulting along the western part of the plateau about 20 million years ago caused further uplifting. The region was raised 5,000 to more than 13,000 feet during this time *(9)*.

The Laramide Orogeny formed high mountains around the lower Plateau region and a downfolded basin at Black Mesa. Consequently, the survey area received much deposition from the eroding highlands during early Tertiary time.

The later part of the Tertiary period was dominated by erosion and degradation, although local deposition did occur *(10)*. Streams from the north and northeast deposited the Bidahochi Formation during the Pliocene. Volcanism in the southern part of the survey area left clusters of basalt diatremes or necks, such as the Hopi Buttes. Volcanic tuff was interbedded with the Bidahochi fluvial deposits *(16)*.

Truncation and erosion of the Black Mesa basin created a dishlike structure with the youngest rocks (the Mesa Verde Formation) at its center. Progressively older rocks crop out in all directions from the center. The Mesa Verde sandstones form the cliffs of Black Mesa. Alluvial and eolian deposits cover most of the older rocks in the surrounding low areas *(15)*.

Early and Middle Pleistocene history was marked chiefly by erosion of the Colorado Plateau. There are few deposits that record this history. Canyons along the main streams were deepened at this time.

During the late Pleistocene Epoch, the Jeddito alluvium was deposited. It can be recognized by its russet color and sand derived dominantly from the Tertiary Bidahochi Formation and the Cretaceous Mesa Verde Sandstone.

During the Recent epoch, three episodes of arroyo cutting, separated by the Tsegi and Naha stages of alluviation, and two major depositions of eolian sand

have occurred, all apparently reflecting climatic changes.

The Tsegi alluvium is distinguished from the Jeddito alluvium by its color, which is gray to brown. The Tsegi alluvium consists principally of crossbedded sand and gravel beds stratified with beds of silt and clay. The deposition occurred in fast- and slow-moving water concentrated in shallow channels. The fine textured sediments were laid down by sluggish streams or in small ponds and swampy areas *(10)*. Dated charcoal indicates that deposition was complete about 1100 A.D.

The period of erosion of the Tsegi Formation was probably short because the arroyos formed by it are deep and sharp and do not have the width that is characteristic of long periods of erosion.

The Naha alluvium followed the short erosional cycle and is composed mostly of loose sand with gravel lenses.

The dune-sand deposits correspond to the drier and windier conditions of the postglacial climate (5000 to 2000 B.C.) *(15)*.

The present episode of arroyo cutting, beginning as early as 1885, abruptly terminated fluvial deposition of sediments and drained swampy areas. The main cutting was especially pronounced between 1880 to 1890 and is still active today.

Parent Material

Most of the soils in the survey area formed either in eolian material or in sediments washed from Black Mesa and laid down by water, or they formed in both kinds of parent material.

Eolian materials have mantled a significant part of the soil survey area. The development of the present eolian cover has occurred over thousands of years, and the vast majority of the dunes in the area are now stabilized by vegetation *(18)*. The existing mantle of eolian material probably originated from primary sources. The most important source was the alluvium on the broad flood plains of Dinnebito, Oraibi, Polacca, and Jeddito Washes *(14)*. Eolian material was probably carried by wind to the leeward side of each wash until the area was mantled. Most of the sand grains in the survey area are well rounded, are very fine or fine, and have frosted surfaces, all indicative of past transport. Many have a reddish hue because of iron oxidation.

The age of the eolian material in the survey area is not known, but it is believed that some of it is much older than the postglacial optimum of climate *(14)*. The eolian materials were rearranged, and many dunes formed during this warm, dry altithermal period about 5000 to 2000 B.C. Most dunes, stable and active, are aligned to the northeast, reflecting the prevailing wind direction. Evidence from the distribution and orientation of numerous dunes and the direction of crossbeds in other eolian deposits indicates similar wind patterns during Quaternary and Tertiary times *(14)*.

The effect of the eolian material on soil morphology is well illustrated in the southern part of the survey area. In the southwestern part of the area, sodic phases of Jocity and Sheppard soils are recognized. The sodium source is sedimentary rocks and sodic dust from the Little Colorado River, upwind from the survey area. The sodium content decreases as distance from the sources increases. Epikom soils on Garces Mesa are sodic. The content of sodium is highest in the surface layer.

In the southeastern part of the survey area, Monue soils with cambic horizons and Nakai soils with well developed calcic horizons and calcium carbonate equivalent of 15 to 50 percent occur in close proximity. No vegetative or landform distinctions are apparent between these two soils. Deep excavations reveal that Nakai soils have bedrock at a depth of 80 to 100 inches and Monue soils have bedrock at a depth of 100 inches or more. The eolian material has mantled a highly dissected landscape where calcium carbonate was leached to a deeper level in the Monue soils because of the greater depth to bedrock.

In contrast to the reddish hue of the eolian materials is the yellowish hue of the alluvium washed down from geologic deposits. Most of the visible outcrops in the survey area are from the Mesozoic era or younger and are covered by a mantle of recent alluvium, colluvium, and eolian deposits. These younger sedimentary rocks have eroded in the Grand Canyon area but are partly preserved on Black Mesa and in the surrounding area. These rocks include the Glen Canyon Group, San Rafael Group, Cow Springs Sandstone, Morrison Formation, Dakota Sandstone, Mancos Shale, and Mesa Verde Formation *(21)*. These sedimentary rocks are sources of sediments washed from Black Mesa and laid down by water. Examples of soils that formed in alluvial deposits are most common along the wide stream terraces of Oraibi, Jeddito, Polacca, and Dinnebito Washes.

Polacca, Wepo, and Querencia soils formed in sediments derived dominantly from shale and sandstone. These soils have cambic horizons, weak stratification, and accumulations of visible carbonates below the cambic horizon. The sediments contribute additional characteristics to the soils. These soil materials have a high cation-exchange capacity and are dominated by montmorillonitic, kaolinitic, and micaceous clays. Sediments with a high percentage of clay form soils that develop stress cutans and have COLE values greater than 0.05. Visible gypsum in some soils is inherited from Mancos Shale sediments. The gypsum is

in solution during transport and precipitates after the sediments are deposited and dried.

Uzona soils, which formed in fine textured sediments on stream terraces, show the effects of water rich in sodium. A saline-sodic spring in the vicinity of the Uzona soils has provided a source of sodium for the natric horizon. Natric horizons formed when clay was dispersed, translocated, and deposited. The sodium provided a large, monovalent cation in high concentration that made excellent conditions for dispersion. Water then carried the clay through conducting channels and planar voids and accumulated in areas where clays were less dispersed.

Climate

Climate plays an important role in the formation of soils. Rainfall erodes soils from steep hills, and runoff transports and deposits sediments downstream. Wind reworks surface particles and distributes them over large areas. Climatic processes provide a source of parent material and influence depth and stability. Climate also contributes to landform development and to the development of geomorphic surfaces and local topography. Indirectly, climate affects soil development through its influence on the number and kinds of plants, animals, and micro-organisms in an area.

As temperature and moisture increase, so do the physical, chemical, and biological processes in the soil. Moisture and temperature control the rate and degree of mineral decomposition and alteration. The leaching of clay, humus, soluble salts, and minerals from the upper part of the solum and their accumulation in layers deeper in the soil profile also are influenced by climate. Nitrogen fixation, carbon transformation, and other microbial activity are strongly affected by soil temperature and moisture.

The survey area has a semiarid, continental climate. Days are warm during the summer and cool in the winter. The temperature decreases and the precipitation increases regularly as the elevation increases. Three soil moisture groups occur in the survey area—Typic Aridic, Ustic Aridic, and Aridic Ustic.

The Typic Aridic zone occurs at elevations of 4,800 to 5,900 feet. Mean annual temperature is 51 to 55 degrees F *(25)*, and the mean annual precipitation is 6 to 10 inches *(32)*. The soils of the lowlands and broad alluvial valleys are in this zone. The most extensive soil series in this zone are Ives, Jocity, Monue, Nakai, Sheppard, and Tewa. The dominant type of vegetation is grassland-shrub.

The Ustic Aridic zone occurs at elevations of 5,700 to 6,800 feet. Mean annual air temperature is 50 to 53 degrees F *(25)*, and the mean annual precipitation is 10 to 14 inches *(32)*. The zone normally commences at the escarpments of highland plateaus and is marked by the presence of scattered Utah juniper and pinyon pine or sagebrush-grassland. Major soil series in this zone are Begay, Mido, and Penistaja.

At the highest elevations on Black Mesa in the northern part of the survey area is the Aridic Ustic zone. This zone has an average annual precipitation of 14 inches or more *(32)*. The vegetation is dominantly Utah juniper and pinyon pine woodland. Soils in this zone are Kydestea and Tonalea.

The soil temperature regime is mesic throughout the survey area.

Certain soil features and properties reflect the influence of local climate. The semiarid climate of the survey area is marked by torrential summer rains and dry, windy springs. Intense summer storms cause rapid runoff, which contributes to the gully erosion and sedimentation problems along major washes. The strong winds intensify the dry climate and deplete soil moisture through high evaporation rates. Loose surface sands are easily eroded and transported by eolian processes. Winds also distribute calcium carbonate in the form of dust. Calcium carbonate and other soluble salts accumulate in zones near the surface because rainfall is insufficient to leach the salts through the profile. This accumulation is especially pronounced in the Typic Aridic soil moisture regime. Soils in the Ustic Aridic and Aridic Ustic moisture regimes are subject to more leaching and commonly have a smaller amount of carbonates in the surface layer. Examples of soils in which carbonates have been leached from the surface layer are Mido, Penistaja, and Tonalea soils. The overall absence of leaching in the survey area results in high base saturation. Soil reaction normally ranges from mildly alkaline to strongly alkaline. Organic matter content generally is low, and the soils have a light-colored surface layer. Soils in the Ustic Aridic and Aridic Ustic moisture regimes support more vegetation than soils in the Typic Aridic moisture regime, and thus they have a higher organic matter content. Most soils in the Typic Aridic soil moisture regime have less than 0.7 percent organic carbon and have plant production of about 400 pounds per acre per year. Soils in the more moist regimes have more than 0.7 percent organic carbon and have plant production of about 600 pounds per acre per year or 3 to 5 cords per acre per year.

Climate is a dynamic factor in soil formation. It fluctuates in seasonal and longer cyclical patterns and has gone through significant changes during geologic time. A change in climate alters the balance of the other soil-forming factors, and soils commonly display features that are a result of past climates. The argillic horizons of Bacobi, Doak, Hano, and Penistaja soils, for example, probably formed in a wetter environment that

provided more water for the translocation and formation of clay. Calcium carbonate inhibits clay movement in soils. The calcium carbonate now present in argillic horizons provides more evidence that clay accumulations occurred during a time of more effective precipitation.

The Colorado Plateau region has undergone many climatic changes in Tertiary and Quaternary times. Geologic and faunal records of the Paleocene and Eocene epochs indicate a humid, warm temperature or subtropical climate with a prevalence of lakes and marshy flood plains. By the mid Oligocene, the climate had changed to semiarid continental. Cooler temperatures and higher effective moisture prevailed in the late Pleistocene. The recent epoch began with a warm, dry period marked by dune activity and arroyo cutting. Alluvium was deposited during a subsequent moist period, followed by another term of downcutting under dry conditions *(19)*. Dated geoclimatic and bioclimatic indicators show that primary hydrologic cycles occur at approximately 550-year intervals, with secondary cycles at 275 years and minor oscillations every 50 to 100 years *(11)*. The effects of these climatic cycles are typically preserved in the alluvial strata beneath more recent alluvium and eolian deposits.

Living Organisms

Among all living organisms, the higher plants have the most significant overall influence on soil formation. Decaying plant remains, especially fibrous grass roots, are the major source of organic matter in soils. Dieback of large plants with tap roots, such as Wyoming big sagebrush or fourwing saltbush, promotes deep penetration of water. Plants of all sizes intercept precipitation, reduce soil erosion, trap sediments, and help to aerate soils. Because the soils in the survey area are dry for long periods of time and are well drained to excessively drained, however, plants cover only a small part of the surface. They add little organic matter to the soil, give scant protection from water and wind, and provide little shade. For these reasons, the soils have a low content of organic matter and are poor habitats for micro-organisms.

Sheppard soils are typical of the somewhat excessively drained soils in the survey area. The surface layer has less organic carbon than the horizon below it. Organic matter in the surface layer is rapidly oxidized during long periods of heat in the summer. It accumulates more in the underlying horizon because the surface layer helps to insulate it.

Because organic matter content is low throughout the survey area, it has little influence on soil color. Soil colors are lithochromic.

Other animals influence soil formation by contributing and synthesizing organic matter. Vertebrate animals, such as small rodents, also turn and mix the soil material while feeding and foraging. Krotovinas, for example, were observed most frequently in the coarse-loamy Monue and Nakai soils.

Relief

The soils on flood plains formed in calcareous alluvium derived dominantly from Mesa Verde sandstones and Mancos Shale. Flood plains occur along Jeddito, Oraibi, and Polacca Washes, which begin high on Black Mesa. The history of these washes is one of constant shifting of stream grade. The grade was steepened during periods of erosion and raised or flattened during periods of deposition *(15)*. During the present erosional cycle, these washes are deeply incised in most of the survey area. Flood plains occur in the southeastern part of the survey area, farthest away from the watershed of Black Mesa, where drainageways are shallow and are characterized by bar and channel topography. The extensive Black Mesa watershed is capable of supplying large amounts of sediment-laden floodwater.

Landscape changes are produced by each flood. New channels are cut as older channels are abandoned, and fresh alluvium is deposited as the floodwater recedes. Coarse soil material is deposited by high-velocity flow. Soil stratification results as fresh alluvium is deposited by varying rates of floodwater flow.

Soils that formed in the wash deposits are Torrifluvents, such as Ives and Jocity soils. The coarse-loamy Ives soils are on the flood plain along Jeddito Wash, and the fine-loamy Jocity soils are on the flood plains along the Oraibi and Polacca Washes. The sandy soil material of Jeddito Wash is probably a result of more extensive dune activity than that which occurred on Oraibi and Polacca Washes.

Stream terraces are abandoned flood plains that were formed when washes were cut down *(17)*. Large areas of stream terraces occur along the major washes, including Dinnebito, Jeddito, Oraibi, and Polacca Washes.

The latest incision of the washes is recent. Oraibi Wash, for example, at the village of Oraibi, is cut to a depth of 80 feet. Historical records indicate that in 1902 the wash was about 10 feet deep and 20 to 30 feet wide. In 1893, before incision, the Hopi were diverting water from the wash for floodwater farming *(15)*.

Typical soils on stream terraces include Torriorthents, such as Jeddito and Naha soils, and Camborthids, such as Polacca and Wepo soils. The cambic horizons on stream terraces are characterized by structure and redistribution of calcium carbonate. The Jeddito soils

are coarse-loamy, and the Naha soils are sandy over loamy. Both soils are in areas where the surface has been reworked by the wind. The Naha soils occur farthest from the channel, and the Jeddito soils are closer to the wash. The loamy material of the Naha soils was deposited in slow-moving waters. The fine textured Wepo soils occur farthest from the washes, where slow-moving waters deposited finer soil materials. Jeddito, Naha, Polacca, and Wepo soils typically have calcium carbonate equivalent of less than 10 percent.

Alluvial fans are characterized by numerous braided, intermittent streams and shallow channels that do not have the capacity to carry runoff and sediments from higher areas. During rare violent floods, alluvium is spread across the soil surface. Large areas of alluvial fans occur around Antelope, Howell, and Padilla Mesas.

The soils on the alluvial fans are best typified by fine-loamy Torrifluvents, such as Jocity soils. Jocity soils formed in mixed alluvium derived dominantly from shale and sandstone of the Mancos Shale and the Mesa Verde Formation. These soils are stratified and have textures ranging from sand to clay. The soils are calcareous throughout because of the calcareous alluvium and calcareous dust *(1)*.

Fan terraces are characterized by broad, coalescent plains that were former alluvial fans and are now incised by intermittent streams. Local relief and the amount of dissection are variable. These surfaces were formed during multiple episodes of incision and backfilling.

Soils that formed on fan terraces include Doak and Bacobi soils. Both soils have argillic horizons. Argillic horizons form on stable surfaces where clay has time to disperse, translocate, and accumulate. The argillic horizons contain calcium carbonate, which probably will accumulate and eventually disrupt and obliterate argillans.

Hills in the survey area are moderately steep to very steep. Slopes typically are 15 to 60 percent and represent metastable to active slopes. The parent material is sedimentary rock, mostly sandstone and shale. Typical soils on hills are Strych, Kydestea, and Zyme. Strych soils are Calciorthids and have calcium carbonate equivalent averaging 15 to 35 percent in the calcic horizon. Kydestea and Zyme soils are Orthents. Strych soils are deep. Even on steep slopes, these soils have a calcic horizon. Calcic horizons formed in these soils when calcium carbonate from dust and basalt went into solution and was transported down and laterally in the soil until it reached a drier zone in which carbon dioxide was depleted. In this zone, the calcium carbonate precipitated and accumulations began. Strych soils on steep slopes have developed calcic horizons partially because of the dominantly fine sandy loam textures, which allow good water infiltration and leaching, and the rock fragments, which help to stabilize the soil. Kydestea and Zyme soils are very shallow and shallow. Soil development in these soils is inhibited by the slope and by the slower permeability.

Plateaus are extensive, gently sloping to undulating plains over a nearly horizontal resistant cap rock. Quaternary alluvium and eolian deposits have mantled the plateaus to form the undulating bedrock-controlled topography.

The edges of the plateaus have received the most recent deposits of eolian sand. Mido soils, which are Ustic Torripsamments, dominate the perimeters of the plateaus and are especially pronounced on the southwestern windward sides. Typically, the Mido soils are leached of carbonates in the upper 6 to 12 inches. Farther from the escarpments, older eolian materials mantle the plateaus in the form of stabilized, longitudinal dunes. Soils associated with the older eolian deposits are Begay, Bighams, Milok, and Penistaja. Begay soils are Ustollic Camborthids with segregated calcium carbonate accumulations. Bighams and Milok soils are Ustollic Calciorthids with calcic horizons that average 15 to 40 percent calcium carbonate equivalent. These soils formed in areas characterized by limestone ridges over calcareous sandstone. The depth to bedrock on the plateaus varies. Areas in which bedrock is within a depth 60 inches are more likely to have calcic horizons because the bedrock acts as an impermeable layer and allows the calcium carbonate to accumulate. Penistaja soils are Ustollic Haplargids. The upper few inches of these soils is leached of carbonates. Although eolian material has influenced the formation of these soils, finer textured alluvium has also played a role. Because the plateaus have been dissected and filled with alluvium and mantled with sand, the location of Penistaja soils is not always predictable on the landscape.

Dunes in the survey area can be classified as longitudinal, or seif; parabolic; transverse; coppice; climbing; and tailing. The type of dune that forms is dependent upon the supply of sand available to the wind, the amount of vegetative cover, and the strength of the wind *(14)*.

Longitudinal, or seif, dunes are long, narrow ridges of sand that extend in the direction of the prevailing wind. These dunes are the most extensive type in the survey area. They are generally 10 to 25 feet high and several hundred feet to several miles long. These dunes form under conditions characterized by one predominant wind direction, a relatively small supply of moving sand,

and a vegetative cover sparse enough to permit the sand to be moved by the wind *(14)*.

Sheppard soils (Typic Torripsamments) are the dominant soils on longitudinal dunes in the 6- to 10-inch precipitation zone. Monue soils (Typic Camborthids) and Nakai soils (Typic Calciorthids) occur in the interdunal areas. Nakai soils are more prevalent in deflated areas in the southeastern part of the survey area adjacent to basalt plugs and dikes, which provide additional sources of calcium carbonate. Mido soils (Ustic Torripsamments) and Begay soils (Ustollic Camborthids) dominate the longitudinal dunes and troughs in the 10- to 14-inch precipitation zone.

Parabolic dunes are long parabolas with tails tapering to windward. Even when active, they support thin stands of vegetation. Aggressive vegetation encroaches and preserves the dune shapes, and the dunes become stabilized. Parabolic dune formation depends on the presence of vegetation and great quantities of eolian sand *(14)*. Sheppard and Mido soils both occur on stabilized parabolic dunes.

Transverse dunes represent a dune form still active in the survey area. These dunes are crescent shaped and have tails pointing to leeward. Formation of these dunes is dependent on large quantities of moving sand and a lack of vegetation. In this survey area, active transverse dunes have been mapped as Dune land.

Coppice dunes are formed by wind in conflict with vegetation. Dunes develop within or to the leeward side of plants that can withstand rapid soil deposition. Coppice dunes in the survey area are covered with Mormon tea, an evergreen shrub with strong rhizomes. Coppice dunes also are useful in evaluating range trends *(18)*. Sheppard soils formed in areas of coppice dunes.

Climbing and tailing dunes form when eolian sand meets obstacles or topographic irregularities. Sand piled up against a cliff by the wind may take the form of a rounded fan. Dunes of this type are climbing dunes. Sand blown off a mesa or plateau may form a solid wall or fan on the leeward side of an escarpment. These dunes are called tailing dunes. Sheppard and Mido soils formed in areas of both of these dune types.

Time

The soils in the survey area vary in age. The time available for a soil to form in unconsolidated sediments is the time that has elapsed since the last sediments were laid down. Eolian materials have mantled much of the landscape. This means that landforms can be much older than the soils upon them. However, some general relationships can be developed with alluvial soils. Flood plains and alluvial fans consist of the most recent alluvium. Fan terraces have older alluvium, and stream terraces are intermediate in age.

Soils on flood plains and alluvial fans show little profile development other than a thin A horizon. In some areas, the A horizon is buried by recent deposition.

Soils on the stream terraces, such as Polacca, Querencia, Tewa, and Wepo soils, have a Bw horizon that is also a cambic horizon. These soils are slightly calcareous (less than 10 percent calcium carbonate) and have structure and carbonate redistribution. The carbonate accumulation consists of a horizon with few filamentary deposits of calcium carbonate *(12)*. The cambic horizons in soils that formed on stream terraces are not redder than the horizons above. This is commonly the case with cambic horizons in soils that formed in calcareous material, and the lack of redness is not necessarily related to age. Cambic horizons formed in slightly calcareous parent materials with low to high content of gravel in New Mexico in 1,100 to 2,000 years under 20 to 25 centimeters precipitation and a thermic soil temperature regime *(13)*.

Soils on fan terraces are the oldest and most strongly developed in the survey area. Doak soils have argillic horizons, which are indicative of clay formation and accumulation over long periods of time. Argids in New Mexico under the same climate mentioned above occur on land surfaces of late Pleistocene age (more than 7,500 years ago) *(13)*.

The argillic horizons in the Hano soils are not redder than the horizons above. Reddish brown and red colors of some argid Bt horizons have been attributed to warm climates, age, or the original parent material *(22)*. If soil hues become redder with time in arid and semiarid areas, then some argillic horizons in the survey area may represent the earlier stages of argillic development *(8)*.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3.5
Low	3.5 to 5.0
Moderate	5.0 to 7.5
High	7.5 to 10
Very high	more than 10

Badland. Steep or very steep, commonly nonstony, barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. A shallow depression from which all or most of the soil material has been removed by the wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Breaks. The steep or very steep broken land at the border of an upland summit that is dissected by ravines.

Brush management. Use of mechanical, chemical, or biological methods to reduce or eliminate competition of woody vegetation to allow understory grasses and forbs to recover or to make conditions favorable for reseeding. Brush management increases production of forage, which reduces the hazard of erosion. It may improve the habitat for some species of wildlife.

Butte. An isolated small mountain or hill with steep or precipitous sides and a top variously flat, rounded, or pointed that may be a residual mass isolated by erosion or an exposed volcanic neck.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Canopy. The leafy crown of trees or shrubs.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax plant community. The plant community on a particular site that will be established if present environmental conditions continue to prevail and the site is properly managed.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coppice dune. A small dune of fine-grained soil material stabilized around shrubs or small trees.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cutan. A modification of the texture, structure, or fabric of natural surfaces in soil materials caused by concentration of particular soil constituents or in situ modification of the plasma. Cutans can be composed of any of the component substances of the soil material.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Desert pavement. A layer of gravel or coarser fragments on a desert soil surface that was emplaced by upward movement of fragments from underlying sediment or remains after finer particles have been removed by running water or wind.

Drainage class (natural). Refers to the frequency and

duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Ephemeral stream. A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no continuous supply from melting snow or other source, and its channel is above the water table at all times.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and produced by erosion or faulting. Synonym: scarp.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salt (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sodium (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Fan terrace. A relict alluvial fan, no longer a site of active deposition, incised by younger and lower alluvial surfaces.

Fast intake (in tables). The rapid movement of water into the soil.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, or clay.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Of or pertaining to rivers; produced by river action, as a fluvial plain.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of the material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

High-residue crops. Crops such as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline. Hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped

according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and are less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Knoll. A small, low, rounded hill rising above adjacent landforms.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat topped and commonly isolated upland mass characterized by summit

widths that are more than the heights of bounding erosional scarps.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Mudstone. Fine textured rock of an indefinite mixture of clay, silt, and sand, which varies in proportions from place to place.

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pediment. A gently sloping erosional surface developed at the foot of a receding hill or mountain.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Potential native plant community. The plant community on a given site that will be established if present environmental conditions continue to

prevail and the site is properly managed. (See Climax plant community.)

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. Proper grazing use increases the vigor and reproduction of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium. In this survey the degrees of salinity, expressed as millimhos per centimeter, are described as:

Slightly saline	4-8
Moderately saline	8-16
Strongly saline	more than 16

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar

in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site class. A grouping of site indexes into 5 to 7 production capability levels. Each level can be represented by a site curve.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey the following slope classes are recognized:

Nearly level	0 to 3 percent
Gently sloping	3 to 7 percent
Strongly sloping	7 to 15 percent
Moderately steep	15 to 25 percent
Steep	25 to 55 percent
Very steep	more than 55 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodic (alkali) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so a high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to Ca^{+} + Mg^{++}. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters).

Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material that is too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1954-85 at Keams Canyon, Arizona)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	43.2	16.0	29.6	60	-10	6	0.84	0.22	1.43	2	1.9
February----	48.9	20.6	34.7	65	-3	25	.80	.34	1.29	2	2.5
March-------	54.8	24.7	39.8	73	5	80	1.23	.25	2.14	3	2.0
April-------	63.9	30.2	47.1	79	11	228	.60	.19	1.04	2	.1
May---------	73.2	38.8	56.0	88	21	472	.47	.15	.89	1	.0
June--------	84.9	47.0	65.9	98	32	734	.31	.07	.70	0	.0
July--------	89.2	55.4	72.3	99	43	970	1.32	.37	2.09	3	.0
August------	85.6	54.7	70.2	97	42	883	1.62	.64	2.54	4	.0
September---	79.4	47.2	63.3	92	31	665	.89	.34	1.53	2	.0
October-----	68.3	35.4	51.8	84	18	352	1.16	0.45	1.97	2	.1
November----	54.7	25.1	39.9	72	3	83	.73	.27	1.20	2	.9
December----	45.2	17.4	31.3	62	-4	10	1.01	.27	1.61	3	3.9
Yearly:											
Average---	65.9	34.4	50.2	---	---	---	---	---	---	---	---
Extreme---	104	-25	---	100	-12	---	---	---	---	---	---
Total-----	---	---	---	---	---	4,509	10.98	8.34	12.98	26	11.4

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1954-85 at Keams Canyon, Arizona)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 15	May 24	June 7
2 years in 10 later than--	May 8	May 17	June 1
5 years in 10 later than--	Apr. 24	May 6	May 20
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 11	Oct. 2	Sept. 19
2 years in 10 earlier than--	Oct. 17	Oct. 7	Sept. 24
5 years in 10 earlier than--	Oct. 27	Oct. 18	Oct. 5

TABLE 3.--GROWING SEASON

(Recorded in the period 1954-85 at Keams Canyon, Arizona)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	156	140	116
8 years in 10	166	148	124
5 years in 10	184	164	139
2 years in 10	202	180	154
1 year in 10	212	188	162

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Coconino County	Navajo County	Total-- Area	Extent
		Acres	Acres	Acres	Pct
1	Bacobi fine sandy loam, 1 to 5 percent slopes	3,750	1,055	4,805	0.3
2	Badland-Torriorthents complex, 8 to 50 percent slopes	25,575	2,890	28,465	1.8
3	Bighams very fine sandy loam, 1 to 8 percent slopes	0	1,525	1,525	0.1
4	Cannonville clay loam, 15 to 50 percent slopes	10,770	14,500	25,270	1.6
5	Doak-Monue complex, 1 to 6 percent slopes	635	3,315	3,950	0.3
6	Dune land	1,325	775	2,100	0.1
7	Epikom very gravelly fine sandy loam, 1 to 5 percent slopes	1,630	0	1,630	0.1
8	Hano fine sandy loam, 2 to 10 percent slopes	1,915	6,810	8,725	0.6
9	Ives fine sandy loam, 0 to 2 percent slopes	4,620	6,300	10,920	0.7
10	Jeddito loamy sand, 0 to 5 percent slopes	10,745	58,385	69,130	4.4
11	Jocity fine sandy loam, 0 to 3 percent slopes	35,565	23,825	59,390	3.8
12	Jocity clay loam, 0 to 2 percent slopes	3,130	930	4,060	0.3
13	Jocity clay loam, sodic, 0 to 2 percent slopes	1,750	0	1,750	0.1
14	Joraibi clay loam, 0 to 2 percent slopes	1,745	30	1,775	0.1
15	Kinan complex, 2 to 12 percent slopes	0	6,725	6,725	0.4
16	Kydestea-Zyme-Tonalea complex, 5 to 50 percent slopes	40,220	150,890	191,110	12.2
17	Mido fine sand, 1 to 15 percent slopes	1,760	36,605	38,365	2.5
18	Mido-Begay complex, 1 to 8 percent slopes	1,795	37,840	39,635	2.5
19	Milok-Mido complex, 1 to 12 percent slopes	135	11,305	11,440	0.7
20	Monue very fine sandy loam, 1 to 5 percent slopes	5,985	17,180	23,165	1.5
21	Naha loamy sand, 0 to 3 percent slopes	1,365	5,395	6,760	0.4
22	Nakai fine sandy loam, 3 to 15 percent slopes	185	4,005	4,190	0.3
23	Nakai-Monue very fine sandy loams, 1 to 5 percent slopes	9,015	68,805	77,820	5.0
24	Penistaja-Begay complex, 1 to 8 percent slopes	8,995	162,375	171,370	11.0
25	Polacca clay loam, 0 to 3 percent slopes	4,365	19,940	24,305	1.6
26	Querencia clay loam, 0 to 3 percent slopes	0	6,420	6,420	0.4
27	Rock outcrop	7,215	0	7,215	0.5
28	Rock outcrop-Torriorthents complex, 5 to 60 percent slopes	14,845	54,385	69,230	4.4
29	Sheppard sand, 1 to 12 percent slopes	110	11,675	11,785	0.8
30	Sheppard sand, sodic, 1 to 8 percent slopes	5,615	0	5,615	0.4
31	Sheppard loamy sand, 1 to 15 percent slopes	51,295	53,285	104,580	6.7
32	Sheppard-Monue complex, 1 to 8 percent slopes	142,614	117,105	259,719	16.6
33	Sheppard-Nakai complex, 1 to 8 percent slopes	405	6,070	6,475	0.4
34	Sheppard-Torriorthents complex, 1 to 8 percent slopes	9,205	10	9,215	0.6
35	Strych-Rock outcrop complex, 25 to 60 percent slopes	0	16,580	16,580	1.1
36	Tewa very fine sandy loam, 1 to 5 percent slopes	28,515	41,035	69,550	4.4
37	Torrifluvents, 0 to 2 percent slopes	3,135	5,905	9,040	0.6
38	Travessilla-Rock outcrop complex, 1 to 8 percent slopes	5,840	42,705	48,545	3.1
39	Typic Torriorthents, 10 to 35 percent slopes	34,755	19,415	54,170	3.5
40	Ustic Torriorthents, 10 to 35 percent slopes	11,345	33,010	44,355	2.8
41	Uzona loam, 0 to 2 percent slopes	0	2,435	2,435	0.2
42	Wepo clay loam, 0 to 3 percent slopes	6,175	11,570	17,745	1.1
	Total	498,044	1,063,010	1,561,054	100.0

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

(Only the soils that support rangeland vegetation suitable for grazing are listed. P.z. means precipitation zone)

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
1 Bacobi	Shale Upland, 6-10" P.z.	Favorable	500	Galleta	20
		Normal	400	Alkali sacaton	25
		Unfavorable	200	Indian ricegrass	15
				Bottlebrush squirreltail	3
				Other perennial grasses	5
				Other perennial forbs	5
				Shadscale	15
				Broom snakeweed	2
				Other shrubs	5
3 Bighams	Sandy Loam Upland, 10-14" P.z.	Favorable	1,000	Needleandthread	25
		Normal	700	Blue grama	15
		Unfavorable	400	Indian ricegrass	20
				Galleta	5
				Bottlebrush squirreltail	5
				Other perennial grasses	5
				Other perennial forbs	5
				Gray horsebrush	2
				Utah juniper	2
				Pinyon	2
				Other shrubs	5
4 Cannonville	Clayey Slopes, 10-14" P.z.	Favorable	650	Indian ricegrass	10
		Normal	450	Bottlebrush squirreltail	5
		Unfavorable	250	Other perennial grasses	5
				Other perennial forbs	5
				Other shrubs	5
				Shadscale	20
				Galleta	25
				Alkali sacaton	10
				Torrey seepweed	3
				Dwarf rabbitbrush	3
				Bigelow sagebrush	5
				Golden buckwheat	3
5:					
Doak	Clay Fan, 6-10" P.z.	Favorable	650	Alkali sacaton	30
		Normal	550	Galleta	20
		Unfavorable	400	Indian ricegrass	5
				Fourwing saltbush	3
				Broom snakeweed	2
				Other perennial grasses	5
				Other perennial forbs	5
				Other shrubs	5
Monue	Sandy Loam Upland, 6-10" P.z.	Favorable	800	Indian ricegrass	30
		Normal	600	Blue grama	15
		Unfavorable	450	Galleta	10
				Needleandthread	10
				Black grama	2
				Cutler Mormon tea	5
				Fourwing saltbush	5
				Broom snakeweed	1
				Other perennial grasses	5
				Other shrubs	5
				Other perennial forbs	5

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
7------------------ Epikom	Sandstone Upland, 6-10" P.z.--	Favorable	500	Galleta	25
		Normal	350	Alkali sacaton	25
		Unfavorable	250	Indian ricegrass	10
				Other perennial grasses	5
				Other perennial forbs	5
				Mound saltbush	10
				Broom snakeweed	2
				Torrey Mormon tea	2
				Other shrubs	5
8------------------ Hano	Sandy Loam Upland (Saline), 10-14" P.z.	Favorable	700	Alkali sacaton	20
		Normal	550	Galleta	25
		Unfavorable	300	Indian ricegrass	10
				Bottlebrush squirreltail	5
				Other perennial grasses	5
				Other perennial forbs	5
				Shadscale	15
				Winterfat	3
				Broom snakeweed	2
				Fourwing saltbush	2
				Other shrubs	5
9------------------ Ives	Sandy Bottom, 6-10" P.z.------	Favorable	1,000	Alkali sacaton	10
		Normal	850	Bottlebrush squirreltail	5
		Unfavorable	600	Western wheatgrass	15
				Sand dropseed	5
				Fourwing saltbush	10
				Other shrubs	5
				Other perennial forbs	5
				Indian ricegrass	20
				Broom snakeweed	2
				Other perennial grasses	5
10----------------- Jeddito	Sandy Terrace, 6-10" P.z.-----	Favorable	750	Indian ricegrass	30
		Normal	550	Galleta	20
		Unfavorable	350	Blue grama	5
				Bottlebrush squirreltail	5
				Other perennial grasses	5
				Fourwing saltbush	10
				Winterfat	3
				Other shrubs	5
				Other perennial forbs	5
11----------------- Jocity	Clay Fan, 6-10" P.z.----------	Favorable	650	Alkali sacaton	20
		Normal	550	Galleta	20
		Unfavorable	400	Bottlebrush squirreltail	5
				Indian ricegrass	5
				Winterfat	5
				Fourwing saltbush	10
				Other perennial grasses	10
				Other perennial forbs	5
				Other shrubs	5
12----------------- Jocity	Loamy Bottom, 6-10" P.z.------	Favorable	2,000	Alkali sacaton	15
		Normal	1,600	Galleta	5
		Unfavorable	1,150	Bottlebrush squirreltail	5
				Indian ricegrass	5
				Fourwing saltbush	20
				Western wheatgrass	30
				Rubber rabbitbrush	2
				Other perennial grasses	10
				Other perennial forbs	5
				Other shrubs	3

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
13 Jocity	Saline Bottom, 6-10" P.z.	Favorable	1,600	Alkali sacaton	30
		Normal	1,100	Galleta	15
		Unfavorable	700	Western wheatgrass	5
				Other perennial grasses	10
				Mound saltbush	5
				Black greasewood	5
				Other shrubs	10
				Other perennial forbs	3
14 Joraibi	Saline Bottom, 6-10" P.z.	Favorable	1,600	Alkali sacaton	30
		Normal	1,100	Galleta	15
		Unfavorable	700	Western wheatgrass	5
				Mound saltbush	5
				Black greasewood	5
				Other perennial grasses	10
				Other shrubs	10
				Other perennial forbs	3
15:					
Kinan	Sandy Loam Upland, 6-10" P.z.	Favorable	800	Galleta	10
		Normal	600	Indian ricegrass	20
		Unfavorable	450	Other perennial grasses	5
				Other perennial forbs	5
				Cutler Mormon tea	5
				Black grama	15
				Blue grama	20
				Greene rabbitbrush	5
				Other shrubs	5
Kinan	Sandy Loam Upland, 6-10" P.z.	Favorable	800	Galleta	10
		Normal	600	Indian ricegrass	20
		Unfavorable	450	Other perennial grasses	5
				Other perennial forbs	5
				Cutler Mormon tea	5
				Black grama	15
				Blue grama	20
				Greene rabbitbrush	5
				Other shrubs	5
16:					
Kydestea*	Sandstone Hills (J-P), 10-14" P.z.	Favorable	500	Galleta	15
		Normal	350	Indian ricegrass	10
		Unfavorable	100	Bottlebrush squirreltail	5
				Other perennial grasses	5
				Other perennial forbs	5
				Bigelow sagebrush	15
				Stansbury cliffrose	15
				Green Mormon tea	5
				Utah juniper	10
				Pinyon	5
				Other shrubs	5
Zyme	Clayey Slopes, 10-14" P.z.	Favorable	650	Indian ricegrass	5
		Normal	450	Bottlebrush squirreltail	10
		Unfavorable	300	Bigelow sagebrush	5
				Galleta	25
				Shadscale	20
				Alkali sacaton	10
				Golden buckwheat	3
				Other perennial grasses	10
				Other perennial forbs	5
				Other shrubs	5

See footnote at end of table.

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
16:					
Tonalea*	Sandy Upland (J-P), 10-14" P.z.	Favorable	700	Indian ricegrass	15
		Normal	500	Needleandthread	10
		Unfavorable	400	Blue grama	5
				Galleta	5
				Other perennial grasses	5
				Other perennial forbs	5
				Wyoming big sagebrush	10
				Stansbury cliffrose	10
				Utah juniper	10
				Pinyon	5
				Other shrubs	5
17 Mido	Sandy Upland, 10-14" P.z.	Favorable	1,000	Blue grama	15
		Normal	650	Sand dropseed	3
		Unfavorable	400	Indian ricegrass	20
				Sandhill muhly	3
				Needleandthread	30
				Other perennial grasses	5
				Other perennial forbs	5
				Cutler Mormon tea	5
				Other shrubs	5
				Bottlebrush squirreltail	3
				Thinstem buckwheat	2
				Sand sagebrush	10
				Utah juniper	2
				Pinyon	1
18:					
Mido	Sandy Upland, 10-14" P.z.	Favorable	1,000	Blue grama	15
		Normal	650	Sand dropseed	3
		Unfavorable	400	Indian ricegrass	20
				Sandhill muhly	3
				Needleandthread	30
				Other perennial grasses	5
				Other perennial forbs	5
				Cutler Mormon tea	5
				Other shrubs	5
				Bottlebrush squirreltail	3
				Thinstem buckwheat	2
				Sand sagebrush	10
				Utah juniper	2
				Pinyon	1
Begay	Sandy Loam Upland, 10-14" P.z.	Favorable	1,000	Needleandthread	20
		Normal	700	Blue grama	15
		Unfavorable	400	Indian ricegrass	20
				Galleta	5
				Bottlebrush squirreltail	5
				Other perennial grasses	5
				Other perennial forbs	5
				Cutler Mormon tea	5
				Greene rabbitbrush	2
				Utah juniper	2
				Pinyon	1
				Other shrubs	5
				Wyoming big sagebrush	3

See footnote at end of table

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Kind of year	Total production Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
19:					
Milok	Sandy Loam Upland, 10-14" P.z.	Favorable	1,000	Needleandthread	20
		Normal	700	Blue grama	15
		Unfavorable	400	Wyoming big sagebrush	3
				Sand dropseed	2
				Bottlebrush squirreltail	5
				Other perennial grasses	5
				Other shrubs	5
				Other perennial forbs	3
				Greene rabbitbrush	2
				Utah juniper	2
				Pinyon	2
				Indian ricegrass	20
Mido	Sandy Upland, 10-14" P.z.	Favorable	1,000	Blue grama	15
		Normal	650	Sand dropseed	3
		Unfavorable	400	Indian ricegrass	20
				Sandhill muhly	3
				Needleandthread	30
				Other perennial grasses	5
				Other perennial forbs	5
				Thinstem buckwheat	2
				Utah juniper	2
				Pinyon	1
				Mormon tea	5
				Sand sagebrush	10
				Bottlebrush squirreltail	3
20 Monue	Sandy Loam Upland, 6-10" P.z.	Favorable	800	Indian ricegrass	30
		Normal	600	Blue grama	15
		Unfavorable	450	Galleta	10
				Needleandthread	10
				Black grama	2
				Cutler Mormon tea	5
				Fourwing saltbush	5
				Broom snakeweed	1
				Other perennial grasses	5
				Other shrubs	5
				Other perennial forbs	5
21 Naha	Sandy Terrace, 6-10" P.z.	Favorable	750	Indian ricegrass	30
		Normal	550	Galleta	20
		Unfavorable	350	Blue grama	5
				Bottlebrush squirreltail	5
				Sand dropseed	5
				Other perennial grasses	5
				Fourwing saltbush	10
				Winterfat	3
				Other shrubs	5
				Other perennial forbs	5
22 Nakai	Sandy Loam Upland, 6-10" P.z.	Favorable	700	Galleta	20
		Normal	500	Indian ricegrass	25
		Unfavorable	300	Other perennial grasses	5
				Other perennial forbs	5
				Fourwing saltbush	5
				Winterfat	5
				Cutler Mormon tea	5
				Other shrubs	5
				Blue grama	15
				Bottlebrush squirreltail	5

See footnote at end of table.

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
23:					
Nakai	Sandy Loam Upland, 6-10" P.z.	Favorable	800	Galleta	15
		Normal	600	Indian ricegrass	25
		Unfavorable	450	Other perennial grasses	5
				Other perennial forbs	5
				Fourwing saltbush	5
				Winterfat	5
				Other shrubs	5
				Blue grama	15
				Bottlebrush squirreltail	5
				Cutler Mormon tea	5
Monue	Sandy Loam Upland, 6-10" P.z.	Favorable	800	Indian ricegrass	30
		Normal	600	Blue grama	15
		Unfavorable	450	Galleta	10
				Needleandthread	10
				Black grama	2
				Other perennial grasses	5
				Other shrubs	5
				Other perennial forbs	5
				Cutler Mormon tea	5
				Fourwing saltbush	5
				Broom snakeweed	1
24:					
Penistaja	Sandy Loam Upland, 10-14" P.z.	Favorable	1,000	Indian ricegrass	20
		Normal	700	Blue grama	15
		Unfavorable	400	Galleta	15
				Cutler Mormon tea	5
				Wyoming big sagebrush	3
				Greene rabbitbrush	2
				Utah juniper	1
				Other shrubs	5
				Bottlebrush squirreltail	5
				Needleandthread	20
				Other perennial forbs	5
				Pinyon	1
				Other perennial grasses	5
Begay	Sandy Loam Upland, 10-14" P.z.	Favorable	1,000	Needleandthread	20
		Normal	700	Blue grama	15
		Unfavorable	400	Indian ricegrass	20
				Galleta	5
				Bottlebrush squirreltail	5
				Other perennial grasses	5
				Other perennial forbs	5
				Cutler Mormon tea	5
				Greene rabbitbrush	2
				Utah juniper	2
				Pinyon	1
				Other shrubs	2
				Wyoming big sagebrush	3

See footnote at end of table.

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
25: Polacca	Clay Fan, 6-10" P.z.	Favorable	650	Alkali sacaton	25
		Normal	550	Galleta	20
		Unfavorable	400	Bottlebrush squirreltail	5
				Western wheatgrass	5
				Other perennial grasses	5
				Fourwing saltbush	10
				Winterfat	5
				Mound saltbush	2
				Other shrubs	5
				Other perennial forbs	5
26: Querencia	Loamy Upland, 10-14" P.z.	Favorable	1,200	Western wheatgrass	30
		Normal	850	Bottlebrush squirreltail	10
		Unfavorable	600	Winterfat	5
				Sand dropseed	5
				Indian ricegrass	5
				Fourwing saltbush	15
				Other perennial grasses	5
				Other perennial forbs	5
				Other shrubs	5
28: Rock outcrop.					
Torriorthents	Breaks, 10-14" P.z.	Favorable	1,100	Galleta	10
		Normal	750	Indian ricegrass	10
		Unfavorable	550	Muttongrass	15
				Golden buckwheat	3
				Other perennial grasses	10
				Other perennial forbs	5
				Green Mormon tea	5
				Utah juniper	5
				Bigelow sagebrush	15
				Other shrubs	5
				Pinyon	5
				Stansbury cliffrose	5
29: Sheppard	Sandy Upland, 6-10" P.z.	Favorable	700	Indian ricegrass	30
		Normal	500	Blue grama	10
		Unfavorable	300	Needleandthread	10
				Sandhill muhly	2
				Other perennial grasses	5
				Other shrubs	5
				Other perennial forbs	5
				Broom snakeweed	5
				Bottlebrush squirreltail	5
				Sand dropseed	2
				Fourwing saltbush	3
				Bigelow rubber rabbitbrush	2
30: Sheppard	Sandy Upland (Sodic), 6-10" P.z.	Favorable	700	Alkali sacaton	30
		Normal	500	Indian ricegrass	20
		Unfavorable	300	Galleta	10
				Spike dropseed	2
				Sandhill muhly	5
				Other perennial grasses	5
				Other perennial forbs	5
				Fourwing saltbush	5
				Broom snakeweed	2
				Other shrubs	5

See footnote at end of table.

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
31----------------- Sheppard	Sandy Upland, 6-10" P.z.------	Favorable	700	Indian ricegrass--------------	30
		Normal	500	Galleta-----------------------	10
		Unfavorable	300	Blue grama--------------------	10
				Needleandthread---------------	10
				Sandhill muhly----------------	5
				Other perennial grasses-------	5
				Other shrubs------------------	5
				Other perennial forbs---------	5
				Cutler Mormon tea-------------	5
				Sand sagebrush----------------	5
				Broom snakeweed---------------	5
32:					
Sheppard----------	Sandy Upland, 6-10" P.z.------	Favorable	700	Indian ricegrass--------------	30
		Normal	500	Galleta-----------------------	10
		Unfavorable	300	Blue grama--------------------	10
				Needleandthread---------------	10
				Sandhill muhly----------------	5
				Other perennial grasses-------	5
				Other shrubs------------------	5
				Other perennial forbs---------	5
				Cutler Mormon tea-------------	5
				Sand sagebrush----------------	5
				Broom snakeweed---------------	5
Monue-------------	Sandy Loam Upland, 6-10" P.z.	Favorable	800	Indian ricegrass--------------	30
		Normal	600	Blue grama--------------------	15
		Unfavorable	450	Galleta-----------------------	10
				Needleandthread---------------	10
				Black grama-------------------	2
				Other perennial grasses-------	5
				Other shrubs------------------	5
				Other perennial forbs---------	5
				Cutler Mormon tea-------------	5
				Fourwing saltbush-------------	5
				Broom snakeweed---------------	1
33:					
Sheppard----------	Sandy Upland, 6-10" P.z.------	Favorable	700	Indian ricegrass--------------	30
		Normal	500	Galleta-----------------------	10
		Unfavorable	300	Blue grama--------------------	10
				Needleandthread---------------	10
				Sandhill muhly----------------	5
				Other perennial grasses-------	5
				Other shrubs------------------	5
				Other perennial forbs---------	5
				Cutler Mormon tea-------------	5
				Sand sagebrush----------------	5
				Broom snakeweed---------------	5
Nakai-------------	Sandy Loam Upland, 6-10" P.z.	Favorable	800	Galleta-----------------------	15
		Normal	600	Indian ricegrass--------------	25
		Unfavorable	450	Other perennial grasses-------	5
				Other perennial forbs---------	5
				Fourwing saltbush-------------	5
				Winterfat---------------------	5
				Other shrubs------------------	5
				Blue grama--------------------	15
				Bottlebrush squirreltail------	5
				Cutler Mormon tea-------------	5

See footnote at end of table.

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
34:					
Sheppard	Sandy Upland (Sodic), 6-10" P.z.	Favorable	700	Alkali sacaton	30
		Normal	500	Indian ricegrass	20
		Unfavorable	300	Galleta	10
				Spike dropseed	2
				Sandhill muhly	5
				Other perennial grasses	5
				Other perennial forbs	5
				Fourwing saltbush	5
				Broom snakeweed	2
				Other shrubs	5
Torriorthents.					
35:					
Strych	Breaks, 10-14" P.z.	Favorable	1,100	Galleta	10
		Normal	750	Blue grama	10
		Unfavorable	550	Black grama	10
				Desert needlegrass	5
				Muttongrass	15
				Bigelow sagebrush	15
				Green Mormon tea	5
				Utah juniper	2
				Other perennial grasses	10
				Other perennial forbs	5
				Other shrubs	10
Rock outcrop.					
36 Tewa	Loamy Upland, 6-10" P.z.	Favorable	700	Galleta	20
		Normal	550	Bottlebrush squirreltail	5
		Unfavorable	300	Indian ricegrass	10
				Blue grama	5
				Alkali sacaton	5
				Other perennial grasses	10
				Fourwing saltbush	10
				Winterfat	5
				Broom snakeweed	2
				Other shrubs	5
				Other perennial forbs	5
38:					
Travessilla*	Sandstone Upland (J-P), 10-14" P.z.	Favorable	600	Indian ricegrass	15
		Normal	400	Needleandthread	10
		Unfavorable	300	Blue grama	5
				Galleta	5
				Bottlebrush squirreltail	3
				Other perennial grasses	5
				Other perennial forbs	5
				Thrifty goldenweed	3
				Bigelow sagebrush	20
				Stansbury cliffrose	5
				Pinyon	5
				Utah juniper	5
				Greene rabbitbrush	2
				Other shrubs	5
Rock outcrop.					

See footnote at end of table.

TABLE 5.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site or woodland site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
39: Typic Torriorthents	Breaks, 6-10" P.z.	Favorable	500	Galleta	20
		Normal	350	Indian ricegrass	10
		Unfavorable	200	Other perennial grasses	5
				Other perennial forbs	5
				Bigelow sagebrush	10
				Alkali sacaton	5
				Shadscale	10
				Torrey Mormon tea	5
				Bottlebrush squirreltail	5
				Other shrubs	5
40: Ustic Torriorthents	Breaks, 10-14" P.z.	Favorable	1,100	Muttongrass	15
		Normal	750	Indian ricegrass	10
		Unfavorable	550	Galleta	10
				Needleandthread	5
				Bottlebrush squirreltail	5
				Other perennial grasses	5
				Other perennial forbs	5
				Bigelow sagebrush	10
				Stansbury cliffrose	10
				Utah juniper	5
				Pinyon	5
				Other shrubs	5
41: Uzona	Saline Bottom, 6-10" P.z.	Favorable	1,600	Alkali sacaton	35
		Normal	1,100	Galleta	10
		Unfavorable	700	Bottlebrush squirreltail	5
				Inland saltgrass	5
				Western wheatgrass	5
				Other perennial grasses	5
				Mound saltbush	10
				Black greasewood	5
				Torrey seepweed	2
				Fourwing saltbush	10
				Other shrubs	5
42: Wepo	Clay Fan, 6-10" P.z.	Favorable	650	Alkali sacaton	30
		Normal	550	Galleta	20
		Unfavorable	400	Bottlebrush squirreltail	5
				Other perennial grasses	5
				Fourwing saltbush	10
				Mound saltbush	2
				Other shrubs	5
				Other perennial forbs	5

* Understory productivity and characteristic plant community for Pinyon-Juniper woodland site. See map unit description for woodland overstory productivity information.

TABLE 6.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1----------------- Bacobi	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: depth to rock.
2:						
Badland.						
Torriorthents.						
3----------------- Bighams	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.	Moderate: depth to rock.
4----------------- Cannonville	Severe: depth to rock, slope.	Severe: shrink-swell, slope.	Severe: depth to rock, slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength, slope.	Severe: slope, depth to rock.
5:						
Doak-------------	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
Monue------------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
6.						
Dune land						
7----------------- Epikom	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones, depth to rock.
8----------------- Hano	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
9----------------- Ives	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: excess salt, droughty, flooding.
10---------------- Jeddito	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
11---------------- Jocity	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
12---------------- Jocity	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
13---------------- Jocity	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: excess salt, droughty.

TABLE 6.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
14---------------- Joraibi	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: excess salt.
15:						
Kinan------------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Severe: small stones.
Kinan------------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
16:						
Kydestea---------	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: small stones, slope.
Zyme-------------	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope, depth to rock.
Tonalea----------	Severe: depth to rock, cutbanks cave.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope.	Moderate: droughty, slope, depth to rock.
17---------------- Mido	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
18:						
Mido-------------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
Begay------------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
19:						
Milok------------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
Mido-------------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
20---------------- Monue	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
21---------------- Naha	Severe: cutbanks cave.	Slight---------	Moderate: shrink-swell.	Slight---------	Slight---------	Moderate: droughty.
22---------------- Nakai	Moderate: depth to rock, slope.	Moderate: slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
23:						
Nakai------------	Slight---------	Slight---------	Moderate: shrink-swell.	Slight---------	Slight---------	Slight.
Monue------------	Slight---------	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
24:						
Penistaja--------	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength.	Slight.

TABLE 6.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
24:						
Begay	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
25 Polacca	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding, shrink-swell.	Slight.
26 Querencia	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: low strength, flooding.	Slight.
27. Rock outcrop						
28:						
Rock outcrop.						
Torriorthents.						
29 Sheppard	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
30 Sheppard	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: excess sodium.
31 Sheppard	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
32:						
Sheppard	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
Monue	Slight	Slight	Slight	Moderate: slope.	Slight	Slight.
33:						
Sheppard	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
Nakai	Slight	Slight	Moderate: shrink-swell.	Moderate: slope.	Slight	Slight.
34:						
Sheppard	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: excess sodium.
Torriorthents.						
35:						
Strych	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: large stones, droughty, slope.
Rock outcrop.						
36 Tewa	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: low strength, flooding.	Slight.

TABLE 6.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
37. Torrifluvents						
38:						
Travessilla	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Rock outcrop.						
39. Typic Torriorthents						
40. Ustic Torriorthents						
41 Uzona	Severe: cutbanks cave.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell.	Severe: shrink-swell, low strength.	Severe: excess salt, excess sodium, droughty.
42 Wepo	Severe: cutbanks cave.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell.	Severe: low strength, shrink-swell.	Slight.

TABLE 7.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1: Bacobi	Severe: depth to rock, percs slowly.	Severe: seepage, depth to rock.	Severe: depth to rock.	Slight	Poor: depth to rock.
2: Badland.					
Torriorthents.					
3: Bighams	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Poor: depth to rock.
4: Cannonville	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: slope.	Poor: depth to rock, hard to pack, slope.
5: Doak	Severe: percs slowly.	Severe: seepage.	Severe: depth to rock.	Slight	Fair: depth to rock, thin layer.
Monue	Slight	Severe: seepage.	Slight	Slight	Good.
6. Dune land					
7: Epikom	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock.	Slight	Poor: depth to rock.
8: Hano	Severe: percs slowly.	Moderate: depth to rock, slope.	Severe: depth to rock, too clayey.	Moderate: depth to rock.	Poor: too clayey, hard to pack.
9: Ives	Severe: flooding.	Severe: flooding.	Severe: flooding, excess salt.	Severe: flooding.	Good.
10: Jeddito	Slight	Severe: seepage.	Slight	Slight	Good.
11, 12: Jocity	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
13: Jocity	Severe: flooding, percs slowly, poor filter.	Severe: seepage, flooding.	Severe: flooding, too sandy.	Severe: flooding.	Poor: seepage, too sandy.

TABLE 7.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
14------------------ Joraibi	Severe: flooding, percs slowly, poor filter.	Severe: seepage, flooding.	Severe: flooding, too sandy.	Severe: flooding.	Poor: seepage, too sandy.
15:					
Kinan--------------	Severe: poor filter.	Severe: seepage, slope.	Severe: too sandy.	Slight-----------	Poor: too sandy.
Kinan--------------	Slight-----------	Severe: seepage, slope.	Severe: too sandy.	Slight-----------	Poor: too sandy.
16:					
Kydestea-----------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, small stones, slope.
Zyme---------------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: slope.	Poor: depth to rock, slope.
Tonalea------------	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: depth to rock, seepage, too sandy.
17------------------ Mido	Severe: poor filter.	Severe: seepage, slope.	Severe: too sandy.	Moderate: slope.	Poor: seepage, too sandy.
18:					
Mido---------------	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Slight-----------	Poor: seepage, too sandy.
Begay--------------	Slight-----------	Severe: seepage.	Slight-----------	Slight-----------	Good.
19:					
Milok--------------	Moderate: depth to rock.	Severe: seepage.	Severe: depth to rock.	Slight-----------	Fair: depth to rock, thin layer.
Mido---------------	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Slight-----------	Poor: seepage, too sandy.
20------------------ Monue	Slight-----------	Severe: seepage.	Slight-----------	Slight-----------	Good.
21------------------ Naha	Severe: percs slowly, poor filter.	Severe: seepage.	Severe: too sandy.	Slight-----------	Poor: too sandy.
22------------------ Nakai	Moderate: depth to rock, slope.	Severe: seepage, slope.	Severe: depth to rock.	Moderate: slope.	Fair: depth to rock, slope, thin layer.

TABLE 7.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
23:					
Nakai	Severe: percs slowly.	Severe: seepage.	Slight	Slight	Good.
Monue	Moderate: percs slowly.	Severe: seepage.	Slight	Slight	Good.
24:					
Penistaja	Moderate: percs slowly.	Severe: seepage.	Slight	Slight	Good.
Begay	Slight	Severe: seepage.	Slight	Slight	Good.
25 Polacca	Severe: percs slowly, poor filter.	Severe: seepage.	Severe: too sandy.	Moderate: flooding.	Poor: seepage, too sandy.
26 Querencia	Moderate: flooding, percs slowly.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.
27. Rock outcrop					
28:					
Rock outcrop.					
Torriorthents.					
29, 30 Sheppard	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Slight	Poor: seepage, too sandy.
31 Sheppard	Severe: poor filter.	Severe: seepage, slope.	Severe: too sandy.	Moderate: slope.	Poor: seepage, too sandy.
32:					
Sheppard	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Slight	Poor: seepage, too sandy.
Monue	Moderate: percs slowly.	Severe: seepage.	Slight	Slight	Good.
33:					
Sheppard	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Slight	Poor: seepage, too sandy.
Nakai	Severe: percs slowly.	Severe: seepage.	Slight	Slight	Good.
34:					
Sheppard	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Slight	Poor: seepage, too sandy.
Torriorthents.					

TABLE 7.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
35:					
Strych	Severe: slope.	Severe: seepage, slope.	Severe: slope, large stones.	Severe: slope.	Poor: large stones, slope.
Rock outcrop.					
36 Tewa	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: flooding.	Moderate: flooding.	Good.
37. Torrifluvents					
38:					
Travessilla	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: depth to rock.
Rock outcrop.					
39. Typic Torriorthents					
40. Ustic Torriorthents					
41 Uzona	Severe: percs slowly.	Severe: seepage.	Severe: excess salt.	Moderate: flooding.	Poor: hard to pack.
42 Wepo	Severe: percs slowly.	Slight	Severe: too clayey.	Moderate: flooding.	Poor: too sandy.

TABLE 8.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1: Bacobi	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, thin layer.
2:				
Badland.				
Torriorthents.				
3: Bighams	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, thin layer.
4: Cannonville	Poor: depth to rock, shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, too clayey, slope.
5:				
Doak	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Monue	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
6. Dune land				
7: Epikom	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock.
8: Hano	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
9: Ives	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
10: Jeddito	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, too clayey.
11, 12: Jocity	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
13: Jocity	Good	Improbable: thin layer.	Improbable: too sandy.	Poor: excess salt.
14: Joraibi	Good	Improbable: thin layer.	Improbable: too sandy.	Poor: excess salt.
15:				
Kinan	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

TABLE 8.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
15:				
Kinan	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
16:				
Kydestea	Poor: depth to rock, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones, slope.
Zyme	Poor: depth to rock, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, too clayey, small stones.
Tonalea	Poor: depth to rock.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy.
17 Mido	Good	Probable	Improbable: too sandy.	Poor: too sandy.
18:				
Mido	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Begay	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
19:				
Milok	Fair: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Mido	Good	Probable	Improbable: too sandy.	Poor: too sandy.
20 Monue	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
21 Naha	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy, thin layer.
22 Nakai	Fair: depth to rock, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
23:				
Nakai	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Monue	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
24:				
Penistaja	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Begay	Good	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 8.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
25: Polacca	Good	Probable	Improbable: too sandy.	Fair: thin layer.
26: Querencia	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
27. Rock outcrop				
28:				
Rock outcrop.				
Torriorthents.				
29: Sheppard	Good	Probable	Improbable: too sandy.	Poor: too sandy.
30: Sheppard	Good	Probable	Improbable: too sandy.	Poor: too sandy, excess sodium.
31: Sheppard	Good	Probable	Improbable: too sandy.	Poor: too sandy.
32:				
Sheppard	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Monue	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
33:				
Sheppard	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Nakai	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
34:				
Sheppard	Good	Probable	Improbable: too sandy.	Poor: too sandy, excess sodium.
Torriorthents.				
35:				
Strych	Poor: slope.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones, area reclaim, slope.
Rock outcrop.				
36: Tewa	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
37. Torrifluvents				

TABLE 8.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
38:				
Travessilla	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock.
Rock outcrop.				
39. Typic Torriorthents				
40. Ustic Torriorthents				
41 Uzona	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
42 Wepo	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

TABLE 9.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Irrigation	Terraces and diversions
1: Bacobi	Severe: seepage.	Severe: thin layer.	Slope, soil blowing, depth to rock.	Depth to rock, soil blowing.
2: Badland.				
Torriorthents.				
3: Bighams	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Soil blowing, depth to rock, slope.	Depth to rock, soil blowing.
4: Cannonville	Severe: depth to rock, slope.	Severe: thin layer.	Slope, percs slowly.	Slope, depth to rock, percs slowly.
5: Doak	Severe: seepage.	Severe: thin layer.	Soil blowing	Erodes easily, soil blowing.
Monue	Severe: seepage.	Severe: piping.	Slope, soil blowing, erodes easily.	Erodes easily, soil blowing.
6. Dune land				
7: Epikom	Severe: depth to rock.	Severe: thin layer.	Slope, depth to rock.	Depth to rock.
8: Hano	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack.	Soil blowing, percs slowly, slope.	Erodes easily, percs slowly.
9: Ives	Moderate: seepage.	Severe: piping, excess salt.	Droughty	Soil blowing.
10: Jeddito	Severe: seepage.	Severe: piping.	Fast intake, soil blowing.	Soil blowing.
11: Jocity	Slight	Severe: piping.	Soil blowing, percs slowly, flooding.	Soil blowing, percs slowly.
12: Jocity	Slight	Severe: piping.	Percs slowly, flooding.	Percs slowly.
13: Jocity	Severe: seepage.	Severe: seepage, piping.	Droughty, percs slowly.	Too sandy.

TABLE 9.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Irrigation	Terraces and diversions
14----------------- Joraibi	Severe: seepage.	Severe: seepage, piping.	Droughty, percs slowly.	Too sandy.
15:				
Kinan------------	Severe: seepage.	Severe: seepage, piping.	Slope, droughty, fast intake.	Too sandy, soil blowing.
Kinan------------	Severe: seepage.	Severe: seepage, piping.	Slope, soil blowing.	Large stones, too sandy.
16:				
Kydestea---------	Severe: depth to rock, slope.	Severe: thin layer.	Droughty, depth to rock, slope.	Slope, large stones, depth to rock.
Zyme-------------	Severe: depth to rock, slope.	Severe: thin layer.	Slope, percs slowly, depth to rock.	Slope, depth to rock, erodes easily.
Tonalea----------	Severe: seepage, slope.	Severe: seepage, piping.	Slope, droughty, fast intake.	Slope, depth to rock, too sandy.
17----------------- Mido	Severe: seepage, slope.	Severe: seepage, piping.	Slope, droughty, fast intake.	Slope, too sandy.
18:				
Mido-------------	Severe: seepage.	Severe: seepage, piping.	Slope, droughty, fast intake.	Erodes easily, too sandy.
Begay------------	Severe: seepage.	Severe: piping.	Slope, fast intake, soil blowing.	Soil blowing.
19:				
Milok------------	Severe: seepage.	Severe: piping.	Slope, soil blowing.	Erodes easily, soil blowing.
Mido-------------	Severe: seepage.	Severe: seepage, piping.	Slope, droughty, fast intake.	Erodes easily, too sandy.
20----------------- Monue	Severe: seepage.	Severe: piping.	Slope, soil blowing, erodes easily.	Erodes easily, soil blowing.
21----------------- Naha	Severe: seepage.	Severe: piping.	Droughty, fast intake, soil blowing.	Too sandy, soil blowing, percs slowly.
22----------------- Nakai	Severe: seepage, slope.	Severe: piping.	Slope, soil blowing.	Slope, soil blowing.

TABLE 9.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Irrigation	Terraces and diversions
23:				
Nakai	Severe: seepage.	Severe: piping.	Slope, soil blowing.	Erodes easily, soil blowing.
Monue	Severe: seepage.	Severe: piping.	Soil blowing, slope.	Soil blowing.
24:				
Penistaja	Severe: seepage.	Severe: piping.	Slope	Favorable.
Begay	Severe: seepage.	Severe: piping.	Slope, soil blowing.	Soil blowing.
25 Polacca	Severe: seepage.	Severe: seepage, piping.	Percs slowly	Too sandy.
26 Querencia	Moderate: seepage.	Severe: piping.	Favorable	Erodes easily.
27. Rock outcrop				
28: Rock outcrop.				
Torriorthents.				
29 Sheppard	Severe: seepage.	Severe: seepage, piping.	Slope, droughty, fast intake.	Too sandy, soil blowing.
30 Sheppard	Severe: seepage.	Severe: seepage, piping, excess sodium.	Slope, droughty, fast intake.	Too sandy, soil blowing.
31 Sheppard	Severe: seepage, slope.	Severe: seepage, piping.	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.
32:				
Sheppard	Severe: seepage.	Severe: seepage, piping.	Slope, droughty, fast intake.	Too sandy, soil blowing.
Monue	Severe: seepage.	Severe: piping.	Soil blowing, slope.	Soil blowing.
33:				
Sheppard	Severe: seepage.	Severe: seepage, piping.	Slope, droughty, fast intake.	Too sandy, soil blowing.
Nakai	Severe: seepage.	Severe: piping.	Slope, soil blowing.	Erodes easily, soil blowing.

TABLE 9.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Irrigation	Features affecting-- Terraces and diversions
34:				
Sheppard	Severe: seepage.	Severe: seepage, piping, excess sodium.	Slope, droughty, fast intake.	Too sandy, soil blowing.
Torriorthents.				
35:				
Strych	Severe: seepage, slope.	Severe: large stones.	Slope, large stones, droughty.	Slope, large stones.
Rock outcrop.				
36 Tewa	Moderate: seepage, slope.	Moderate: piping.	Soil blowing, slope.	Erodes easily, soil blowing.
37. Torrifluvents				
38:				
Travessilla	Severe: depth to rock.	Severe: thin layer.	Slope, soil blowing, depth to rock.	Depth to rock, soil blowing.
Rock outcrop.				
39. Typic Torriorthents				
40. Ustic Torriorthents				
41 Uzona	Severe: seepage.	Severe: excess sodium, excess salt.	Droughty, percs slowly, erodes easily.	Erodes easily, percs slowly.
42 Wepo	Slight	Moderate: hard to pack.	Percs slowly, excess salt.	Too sandy, percs slowly.

TABLE 10.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
1---------------- Bacobi	0-2	Fine sandy loam	SM, ML	A-4	0	100	100	80-90	40-55	15-20	NP-5
	2-15	Very fine sandy loam, fine sandy loam.	CL-ML, SM-SC, ML, SM	A-4	0	100	100	80-90	45-60	15-25	NP-10
	15-26	Sandy clay loam	SC	A-6	0	100	100	80-90	35-50	25-35	10-20
	26-36	Fine sandy loam	SM	A-4	0	90-100	85-100	65-80	35-50	15-20	NP-5
	36-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
2: Badland.											
Torriorthents.											
3---------------- Bighams	0-2	Very fine sandy loam.	SM, ML	A-4	0	100	100	80-90	45-60	15-20	NP-5
	2-17	Fine sandy loam	SM, SM-SC	A-4	0	100	100	70-85	40-45	15-25	NP-10
	17-35	Sandy clay loam	CL, SC	A-6	0	100	100	80-90	35-55	25-35	10-15
	35-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
4---------------- Cannonville	0-5	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	80-90	55-75	30-45	10-20
	5-12	Clay, clay loam	CL, CH	A-7	0	95-100	95-100	80-100	65-90	40-55	20-35
	12-75	Weathered bedrock	---	---	---	---	---	---	---	---	---
5: Doak------------	0-15	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	100	75-85	30-50	15-20	NP-5
	15-33	Sandy clay loam, loam, clay loam.	CL	A-6	0	100	95-100	80-100	60-80	25-40	10-20
	33-47	Fine sandy loam	SM, SM-SC	A-4	0	100	100	70-85	40-45	15-25	NP-10
	47-51	Weathered bedrock	---	---	---	---	---	---	---	---	---
Monue-----------	0-1	Very fine sandy loam.	ML, CL-ML	A-4	0	100	100	80-95	50-65	15-25	NP-5
	1-46	Fine sandy loam	SM, SM-SC	A-2, A-4	0	95-100	95-100	70-85	30-50	15-20	NP-5
	46-84	Loamy fine sand	SM	A-2	0	100	100	65-80	25-35	---	NP
6. Dune land											
7---------------- Epikom	0-1	Very gravelly fine sandy loam.	GM-GC, GM, GP-GM, GC	A-2, A-1	0	35-60	25-50	20-40	10-25	15-25	NP-10
	1-5	Fine sandy loam	SM-SC, SC	A-2, A-4	0	100	95-100	65-85	30-45	20-25	5-10
	5-13	Loam, sandy clay loam.	SC	A-6	0	100	95-100	75-90	40-50	25-30	10-15
	13-17	Gravelly loam----	SC, SM-SC, GC, GM-GC	A-2, A-4, A-6	0	60-75	50-75	40-60	30-50	20-30	5-15
	17-21	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
8---------------- Hano	0-3	Fine sandy loam	ML, CL-ML	A-4	0	100	100	80-90	50-60	20-25	NP-10
	3-8	Sandy clay loam, clay loam.	SC, CL	A-6	0	95-100	95-100	80-100	45-60	25-40	10-20
	8-22	Clay loam, clay	CL, CH	A-7	0	95-100	95-100	85-100	70-90	40-55	20-30
	22-42	Clay loam, clay, silty clay.	CL, CH	A-7	0	95-100	95-100	90-100	70-95	40-60	20-35
	42-84	Weathered bedrock	---	---	---	---	---	---	---	---	---
9---------------- Ives	0-3	Fine sandy loam	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	20-25	NP-5
	3-84	Fine sandy loam	SM, SM-SC	A-4	0	100	100	70-85	35-50	20-25	NP-5

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
10---------------- Jeddito	0-2	Loamy sand-------	SM	A-2, A-1	0	100	100	45-70	15-20	---	NP
	2-9	Fine sandy loam	SM, SM-SC	A-4	0	100	100	70-85	40-50	15-20	NP-5
	9-27	Stratified sand to clay.	SM, SM-SC	A-2, A-4	0	100	95-100	60-70	20-40	15-20	NP-5
	27-84	Fine sandy loam	SM, SM-SC	A-4	0	100	100	70-85	40-50	15-20	NP-5
11---------------- Jocity	0-3	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-4	0	100	100	70-85	40-55	15-25	NP-10
	3-84	Stratified sandy clay loam to clay loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	100	95-100	70-90	35-70	25-40	5-15
12---------------- Jocity	0-12	Clay loam--------	CL, ML	A-6	0	100	100	90-100	70-80	35-40	10-15
	12-84	Stratified sandy clay loam to clay loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	100	95-100	70-90	35-70	25-40	5-15
13---------------- Jocity	0-1	Clay loam--------	CL	A-6	0	100	95-100	80-100	50-80	30-40	10-15
	1-24	Stratified clay loam to sandy clay loam.	CL, CL-ML, SC, SM-SC	A-6, A-4	0	100	95-100	70-90	35-70	25-40	5-15
	24-84	Stratified clay loam to clay.	CL-ML, CL	A-4, A-6	0	100	100	85-100	65-90	25-40	5-15
14---------------- Joraibi	0-2	Clay loam--------	CL, ML	A-6, A-7	0	100	100	90-100	70-80	35-45	10-20
	2-23	Stratified clay loam to very fine sandy loam.	CL	A-6, A-7	0	100	100	80-90	65-75	30-45	10-20
	23-54	Stratified sand to very fine sandy loam.	SM, SP-SM	A-2, A-3	0	100	100	50-70	5-15	---	NP
	54-84	Stratified very fine sandy loam to clay loam.	CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	25-40	5-15
15: Kinan-----------	0-1	Very gravelly loamy fine sand.	SP-SM, SM, GP-GM, GM	A-1	0-10	45-60	35-50	25-40	5-15	---	NP
	1-12	Fine sandy loam, sandy loam, very fine sandy loam.	SM, ML, CL-ML, SM-SC	A-2, A-4	0-10	95-100	85-95	60-85	30-55	15-25	NP-5
	12-30	Gravelly sandy loam, gravelly fine sandy loam, loam.	SM, ML, CL-ML, SM-SC	A-2, A-4	0-10	80-100	70-95	50-75	30-55	15-25	NP-5
	30-84	Gravelly fine sand, fine sand, sand.	SM, SP-SM	A-2	0-10	80-100	70-95	50-70	10-30	---	NP
Kinan-----------	0-2	Fine sandy loam	SM, SM-SC	A-4	0	95-100	90-95	65-80	35-45	15-25	NP-5
	2-23	Fine sandy loam, sandy loam, very fine sandy loam.	SM, ML, CL-ML, SM-SC	A-2, A-4	0-10	95-100	90-95	60-85	30-55	15-25	NP-5
	23-65	Gravelly very fine sandy loam, very cobbly very fine sandy loam.	SM, SM-SC, GM-GC, GP-GM	A-1, A-2, A-4	10-60	45-85	40-75	30-70	10-50	15-30	NP-10
	65-84	Gravelly fine sand, fine sand, sand.	SM, SP-SM	A-2	0-10	80-100	70-95	50-70	10-30	---	NP

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
16:											
Kydestea	0-1	Very channery sandy clay loam.	GC	A-2	0-15	50-60	35-50	30-45	15-30	30-40	10-20
	1-5	Very channery sandy clay loam, very channery clay loam.	GC	A-2	0-15	50-60	35-50	30-45	15-35	30-40	10-20
	5-15	Extremely channery sandy clay loam, extremely channery clay loam.	GC, GP-GC	A-2	5-25	35-45	25-35	20-30	10-25	30-40	10-20
	15-19	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Zyme	0-1	Clay loam	CL, CH	A-7	0-10	85-100	80-100	75-95	70-90	45-55	25-35
	1-18	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-10	90-100	85-100	75-100	70-95	45-60	25-40
	18-22	Weathered bedrock	---	---	---	---	---	---	---	---	---
Tonalea	0-3	Loamy fine sand	SM	A-2	0	100	100	60-75	15-25	---	NP
	3-24	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	50-75	5-20	---	NP
	24-26	Weathered bedrock	---	---	---	---	---	---	---	---	---
	26-30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
17 Mido	0-3	Fine sand	SM	A-2	0	100	100	65-80	10-20	---	NP
	3-84	Loamy fine sand, fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	100	100	70-95	5-35	---	NP
18:											
Mido	0-3	Loamy fine sand	SM	A-2, A-4	0	100	100	75-95	30-50	---	NP
	3-84	Loamy fine sand, fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	100	100	70-95	5-35	---	NP
Begay	0-14	Loamy sand	SM, SP-SM	A-2, A-3	0	100	100	55-80	5-20	---	NP
	14-84	Fine sandy loam, loamy fine sand.	SM, SM-SC, SC	A-2, A-4	0	100	100	65-85	15-50	10-20	NP-10
19:											
Milok	0-2	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	85-100	80-95	30-50	15-20	NP-5
	2-15	Very fine sandy loam, gravelly very fine sandy loam.	CL-ML, ML, SM, SM-SC	A-2, A-4	0	70-100	60-100	50-95	30-80	15-25	NP-10
	15-35	Fine sandy loam, sandy loam.	SM, SM-SC	A-2, A-4	0	80-100	80-100	55-90	30-50	15-25	NP-5
	35-55	Loamy sand, gravelly loamy sand, fine sand.	SM, SP-SM	A-2	0	80-100	70-100	50-80	10-20	---	NP
	55-59	Weathered bedrock	---	---	---	---	---	---	---	---	---

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
19:											
Mido	0-2	Loamy fine sand	SM	A-2, A-4	0	100	100	75-95	30-50	---	NP
	2-57	Loamy fine sand, fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	100	100	70-95	5-35	---	NP
	57-84	Loamy sand, gravelly loamy sand.	SM	A-1, A-2	0	65-100	60-100	30-75	15-25	---	NP
20 Monue	0-1	Very fine sandy loam.	ML, CL-ML	A-4	0	100	100	80-95	50-65	15-25	NP-5
	1-46	Fine sandy loam	SM, SM-SC	A-2, A-4	0	95-100	95-100	70-85	30-50	15-20	NP-5
	46-84	Loamy fine sand	SM	A-2	0	100	100	65-80	25-35	---	NP
21 Naha	0-2	Loamy sand	SM	A-2	0	100	100	60-80	10-15	---	NP
	2-27	Loamy sand, loamy fine sand.	SM	A-2	0	100	100	60-80	10-15	---	NP
	27-58	Stratified sand to clay.	CL-ML, CL	A-4, A-6	0	100	100	85-95	60-75	25-40	5-15
	58-84	Sandy loam	SM	A-2, A-4	0	100	100	55-70	30-40	15-20	NP-5
22 Nakai	0-2	Fine sandy loam	SM, SM-SC	A-4	0	100	100	80-95	40-60	15-25	NP-5
	2-41	Fine sandy loam	SM, SM-SC	A-4	0	100	100	80-95	40-60	15-25	NP-5
	41-45	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
23:											
Nakai	0-3	Very fine sandy loam.	CL-ML, ML, CL	A-4	0	100	100	85-95	50-65	15-25	NP-10
	3-30	Fine sandy loam, very fine sandy loam.	ML, SM, CL-ML, SM-SC	A-4	0	100	100	70-100	45-65	15-25	NP-10
	30-84	Sandy clay loam	SC, CL	A-6	0	100	100	80-90	35-55	25-35	10-15
Monue	0-2	Very fine sandy loam.	SM, ML	A-4	0	100	100	80-95	40-60	15-20	NP-5
	2-84	Fine sandy loam, very fine sandy loam.	SM, SM-SC, ML, CL-ML	A-4	0	100	100	80-95	40-60	15-25	NP-10
24:											
Penistaja	0-2	Fine sandy loam	SM-SC, CL-ML	A-4	0	100	100	90-100	40-60	20-30	5-10
	2-18	Sandy clay loam, clay loam.	CL, SC	A-6	0	100	100	95-100	45-75	30-35	10-15
	18-58	Sandy loam, fine sandy loam, sandy clay loam.	SC, SM-SC, CL, CL-ML	A-2, A-4, A-6	0	100	100	70-95	30-55	20-30	5-15
	58-84	Gravelly loamy sand.	SM	A-1, A-2	0	65-80	60-75	30-55	15-25	10-15	NP
Begay	0-4	Very fine sandy loam.	SM, SM-SC, ML, CL-ML	A-4	0	100	100	75-90	40-60	15-25	NP-10
	4-57	Fine sandy loam, very fine sandy loam.	SM, SM-SC, SC	A-4	0	100	100	65-90	35-50	15-25	NP-10
	57-84	Loamy sand, loamy fine sand.	SM	A-2	0	100	100	55-70	20-35	---	NP

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
25--------------- Polacca	0-3	Clay loam--------	CL-ML, CL, SM-SC, SC	A-4, A-6	0	95-100	95-100	80-90	45-70	25-35	5-15
	3-33	Stratified sandy loam to clay.	CL, SC	A-6	0	95-100	95-100	70-95	40-70	25-35	10-15
	33-84	Loamy sand, sand	SM, SP-SM	A-2, A-3	0	95-100	95-100	50-65	5-20	---	NP
26--------------- Querencia	0-1	Clay loam--------	CL, SC	A-6	0	90-100	85-100	70-90	35-75	25-45	10-20
	1-33	Loam, sandy clay loam, clay loam.	CL	A-6	0	90-100	85-100	65-80	55-70	25-35	10-15
	33-84	Loam, fine sandy loam, sandy clay loam.	CL-ML, SM-SC	A-4	0	90-100	85-100	60-75	45-60	25-30	5-10
27. Rock outcrop											
28: Rock outcrop.											
Torriorthents.											
29--------------- Sheppard	0-1	Sand-------------	SP-SM	A-3, A-2	0	100	100	50-70	5-10	---	NP
	1-84	Sand, loamy sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	50-75	5-20	---	NP
30--------------- Sheppard	0-1	Sand-------------	SM, SP-SM	A-3, A-2	0	100	100	50-75	5-15	---	NP
	1-84	Sand, fine sand, loamy fine sand.	SM, SP-SM	A-3, A-2	0	100	100	50-80	5-20	---	NP
31--------------- Sheppard	0-2	Loamy sand-------	SM	A-2	0	100	100	50-75	15-20	---	NP
	2-84	Fine sand, loamy sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	50-80	10-35	---	NP
32: Sheppard--------	0-2	Loamy sand-------	SM	A-2	0	100	100	50-75	15-20	---	NP
	2-84	Fine sand, loamy sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	50-80	10-35	---	NP
Monue-----------	0-5	Fine sandy loam	SM, ML	A-4	0	100	100	80-95	40-60	15-20	NP-5
	5-84	Sandy loam, fine sandy loam, very fine sandy loam.	SM, SM-SC, ML, CL-ML	A-4	0	100	95-100	70-85	35-55	15-25	NP-10
33: Sheppard--------	0-9	Loamy sand-------	SM	A-2	0	100	100	50-75	15-20	---	NP
	9-84	Fine sand, loamy sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	50-80	10-35	---	NP
Nakai-----------	0-3	Very fine sandy loam.	CL-ML, ML, CL	A-4	0	100	100	85-95	50-65	15-25	NP-10
	3-84	Fine sandy loam, very fine sandy loam.	ML, SM, CL-ML, SM-SC	A-4	0	100	100	70-100	45-65	15-25	NP-10

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
34:											
Sheppard--------	0-2	Sand-------------	SM, SP-SM	A-3, A-2	0	100	100	50-75	5-15	---	NP
	2-84	Sand, fine sand, loamy fine sand.	SM, SP-SM	A-3, A-2	0	100	100	50-80	5-20	---	NP
Torriorthents.											
35:											
Strych----------	0-2	Extremely cobbly fine sandy loam.	SM, SM-SC	A-2	50-70	70-80	60-90	50-60	25-35	15-25	NP-5
	2-9	Very gravelly loam.	GM-GC, GC	A-1, A-2	5-15	40-60	35-55	30-45	20-35	20-30	5-10
	9-23	Very stony fine sandy loam.	SM, SM-SC	A-2, A-1	15-50	70-85	55-85	40-55	20-30	15-25	NP-5
	23-60	Extremely stony fine sandy loam.	SM, SM-SC	A-2	50-70	70-80	60-75	50-60	25-35	15-25	NP-5
Rock outcrop.											
36--------------- Tewa	0-1	Very fine sandy loam.	SM, SM-SC, SC	A-4	0	100	100	75-90	40-50	15-25	NP-10
	1-25	Sandy clay loam, clay loam.	CL	A-6	0	100	100	85-95	50-70	30-40	10-15
	25-31	Fine sandy loam	SM, SM-SC, SC	A-4	0	100	95-100	70-85	40-50	15-25	NP-10
	31-84	Sandy clay loam, clay loam.	SC, CL	A-6	0	100	95-100	85-95	45-70	30-40	10-15
37. Torrifluvents											
38:											
Travessilla-----	0-1	Very fine sandy loam.	SM, ML	A-4	0	100	100	75-90	40-60	15-20	NP-5
	1-11	Fine sandy loam	SM, SM-SC	A-4	0	100	85-100	70-85	40-50	15-20	NP-10
	11-15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
39. Typic Torriorthents											
40. Ustic Torriorthents											
41--------------- Uzona	0-1	Loam-------------	CL-ML, CL	A-4	0	100	100	85-95	60-75	25-30	5-10
	1-45	Clay loam, clay, sandy clay.	CL, CH	A-7	0	100	100	90-100	70-85	40-60	20-35
	45-58	Sandy clay loam	CL-ML, CL, SM-SC, SC	A-4, A-6	0	100	100	80-90	35-55	25-35	5-15
	58-84	Fine sand, loamy fine sand.	SM	A-2	0	100	100	70-80	15-25	---	NP
42--------------- Wepo	0-3	Clay loam--------	CL	A-7	0	100	100	90-100	70-80	40-45	20-25
	3-32	Clay loam, clay, silty clay.	CL, CH	A-7	0	100	100	90-100	75-90	40-55	20-35
	32-84	Stratified sand to clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-55	20-35

TABLE 11.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	In/hr	In/in	pH	mmhos/cm				
1---------------- Bacobi	0-2	3-15	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low----------	0.28	2	3
	2-15	10-20	0.6-2.0	0.15-0.17	7.9-8.4	<2	Low----------	0.32		
	15-26	20-27	0.2-0.6	0.14-0.16	7.9-8.4	<2	Moderate-----	0.28		
	26-36	10-15	2.0-6.0	0.13-0.15	7.9-8.4	<2	Low----------	0.28		
	36-60	---	---	---	---	---	-------------	----		
2: Badland.										
Torriorthents.										
3---------------- Bighams	0-2	10-15	2.0-6.0	0.14-0.16	7.4-8.4	<2	Low----------	0.32	2	3
	2-17	10-20	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low----------	0.32		
	17-35	20-30	0.6-2.0	0.14-0.16	7.4-8.4	<2	Moderate-----	0.28		
	35-60	---	---	---	---	---	-------------	----		
4---------------- Cannonville	0-5	27-40	0.2-0.6	0.14-0.18	7.4-9.0	4-8	Moderate-----	0.28	1	6
	5-12	35-50	0.06-0.2	0.10-0.18	7.9-9.0	4-8	High---------	0.28		
	12-75	---	---	---	---	---	-------------	----		
5: Doak------------	0-15	5-20	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low----------	0.24	3	3
	15-33	20-35	0.2-0.6	0.12-0.15	7.9-9.0	2-4	Moderate-----	0.37		
	33-47	10-20	2.0-6.0	0.11-0.13	7.9-9.0	2-4	Low----------	0.28		
	47-51	---	---	---	---	---	-------------	----		
Monue-----------	0-1	5-15	0.6-2.0	0.13-0.17	7.4-8.4	<2	Low----------	0.37	5	3
	1-46	10-18	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low----------	0.24		
	46-84	0-5	6.0-20	0.06-0.08	7.4-8.4	<2	Low----------	0.24		
6. Dune land										
7---------------- Epikom	0-1	10-20	2.0-6.0	0.05-0.09	7.9-8.4	<2	Low----------	0.10	1	8
	1-5	15-20	2.0-6.0	0.13-0.15	7.9-9.0	<2	Low----------	0.28		
	5-13	20-25	2.0-6.0	0.14-0.18	7.9-9.0	<2	Low----------	0.32		
	13-17	20-25	2.0-6.0	0.09-0.12	7.9-9.0	<2	Low----------	0.24		
	17-21	---	---	---	---	---	-------------	----		
8---------------- Hano	0-3	15-20	0.6-2.0	0.13-0.15	7.4-8.4	<2	Low----------	0.37	3	3
	3-8	20-35	0.2-0.6	0.15-0.20	7.4-8.4	<4	Moderate-----	0.28		
	8-22	35-50	0.06-0.6	0.14-0.20	7.4-8.4	2-8	High---------	0.24		
	22-42	35-55	0.06-0.2	0.10-0.18	7.4-8.4	2-8	High---------	0.24		
	42-84	---	---	---	---	---	-------------	----		
9---------------- Ives	0-3	10-15	2.0-6.0	0.03-0.04	7.9-9.0	>16	Low----------	0.24	5	3
	3-84	10-15	0.6-2.0	0.03-0.04	7.4-9.0	>16	Low----------	0.24		
10--------------- Jeddito	0-2	5-10	6.0-20	0.08-0.11	7.4-8.4	<2	Low----------	0.15	5	2
	2-9	10-15	2.0-6.0	0.11-0.13	7.4-8.4	<2	Low----------	0.24		
	9-27	10-15	2.0-6.0	0.12-0.14	7.4-8.4	2-4	Low----------	0.20		
	27-84	10-15	2.0-6.0	0.11-0.13	7.4-8.4	2-4	Low----------	0.24		
11--------------- Jocity	0-3	7-18	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low----------	0.28	5	3
	3-84	20-35	0.06-0.2	0.14-0.18	7.9-8.4	<2	Moderate-----	0.32		

TABLE 11.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	In/hr	In/in	pH	mmhos/cm				
12--------------- Jocity	0-12	30-35	0.2-0.6	0.18-0.20	7.4-8.4	<2	Moderate-----	0.32	5	4L
	12-84	20-35	0.06-0.2	0.14-0.18	7.9-8.4	<2	Moderate-----	0.32		
13--------------- Jocity	0-1	25-35	0.06-0.2	0.03-0.10	>7.8	8-16	Moderate-----	0.24	5	4L
	1-24	20-35	0.2-0.6	0.04-0.12	>7.8	8-16	Moderate-----	0.24		
	24-84	20-35	0.06-0.2	0.04-0.10	7.4-9.0	8-16	Moderate-----	0.37		
14--------------- Joraibi	0-2	30-40	0.06-0.2	0.12-0.16	>7.8	2-16	Moderate-----	0.28	5	4L
	2-23	27-40	0.2-0.6	0.10-0.14	>7.8	2-16	Moderate-----	0.24		
	23-54	5-8	6.0-20	0.04-0.07	7.9-9.0	2-16	Low----------	0.15		
	54-84	20-35	0.06-0.2	0.08-0.12	7.4-9.0	2-16	Moderate-----	0.37		
15:										
Kinan-----------	0-1	3-10	6.0-20	0.05-0.06	7.4-8.4	<2	Low----------	0.10	5	3
	1-12	10-20	2.0-6.0	0.11-0.14	7.4-8.4	<2	Low----------	0.24		
	12-30	10-18	2.0-6.0	0.10-0.15	7.9-8.4	<2	Low----------	0.24		
	30-84	3-8	6.0-20	0.04-0.07	7.9-8.4	<2	Low----------	0.15		
Kinan-----------	0-2	10-20	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low----------	0.28	5	3
	2-23	10-20	2.0-6.0	0.11-0.14	7.4-8.4	<2	Low----------	0.24		
	23-65	10-20	2.0-6.0	0.11-0.14	7.9-8.4	<2	Low----------	0.24		
	65-84	3-8	6.0-20	0.04-0.07	7.9-8.4	<2	Low----------	0.15		
16:										
Kydestea--------	0-1	25-35	0.2-0.6	0.07-0.10	7.4-7.8	<2	Moderate-----	0.15	1	8
	1-5	25-35	0.2-0.6	0.08-0.12	7.4-8.4	<4	Moderate-----	0.15		
	5-15	25-35	0.2-0.6	0.06-0.10	7.4-8.4	<4	Moderate-----	0.05		
	15-19	---	---	---	---	---	-------------	----		
Zyme------------	0-1	35-40	0.2-0.6	0.16-0.20	7.4-8.4	<2	High---------	0.43	1	4
	1-18	35-45	0.06-0.2	0.14-0.19	7.4-8.4	<2	High---------	0.43		
	18-22	---	---	---	---	---	-------------	----		
Tonalea---------	0-3	5-10	6.0-20	0.09-0.11	7.4-7.8	<2	Low----------	0.20	2	2
	3-24	5-10	6.0-20	0.06-0.09	7.4-8.4	<2	Low----------	0.20		
	24-26	---	---	---	---	---	-------------	----		
	26-30	---	---	---	---	---	-------------	----		
17--------------- Mido	0-3	1-5	6.0-20	0.05-0.07	7.4-9.0	<2	Low----------	0.17	5	1
	3-84	3-8	6.0-20	0.05-0.09	7.4-9.0	<2	Low----------	0.32		
18:										
Mido------------	0-3	2-10	6.0-20	0.08-0.10	7.4-9.0	<2	Low----------	0.37	5	2
	3-84	3-8	6.0-20	0.05-0.09	7.9-9.0	<2	Low----------	0.32		
Begay-----------	0-14	5-10	6.0-20	0.07-0.10	7.4-8.4	<2	Low----------	0.15	5	2
	14-84	5-15	2.0-6.0	0.09-0.15	7.9-8.4	<2	Low----------	0.24		
19:										
Milok-----------	0-2	10-15	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low----------	0.24	4	3
	2-15	5-15	0.2-0.6	0.11-0.17	7.9-8.4	<2	Low----------	0.37		
	15-35	10-20	2.0-6.0	0.10-0.12	7.9-8.4	<2	Low----------	0.20		
	35-55	5-10	6.0-20	0.05-0.08	7.9-8.4	<2	Low----------	0.17		
	55-59	5-10	---	---	---	---	-------------	----		
Mido------------	0-2	2-10	6.0-20	0.08-0.10	7.9-9.0	<2	Low----------	0.37	5	2
	2-57	3-8	6.0-20	0.05-0.09	7.9-9.0	<2	Low----------	0.32		
	57-84	5-10	6.0-20	0.04-0.08	7.9-9.0	<2	Low----------	0.20		

TABLE 11.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	In/hr	In/in	pH	mmhos/cm				
20--------------- Monue	0-1	5-15	0.6-2.0	0.13-0.17	7.4-8.4	<2	Low----------	0.37	5	3
	1-46	10-18	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low----------	0.24		
	46-84	0-5	6.0-20	0.06-0.08	7.4-8.4	<2	Low----------	0.24		
21--------------- Naha	0-2	3-8	6.0-20	0.06-0.08	7.4-7.8	<2	Low----------	0.15	5	1
	2-27	3-8	6.0-20	0.06-0.08	7.4-7.8	<2	Low----------	0.15		
	27-58	15-35	0.06-0.2	0.16-0.18	7.4-8.4	<2	Moderate-----	0.32		
	58-84	10-15	2.0-6.0	0.10-0.12	7.4-8.4	<2	Low----------	0.24		
22--------------- Nakai	0-2	10-18	2.0-6.0	0.10-0.16	7.4-8.4	<2	Low----------	0.28	3	3
	2-41	10-18	2.0-6.0	0.10-0.16	>7.3	<2	Low----------	0.28		
	41-45	---	---	---	---	---	-------------	----		
23: Nakai-----------	0-3	8-18	2.0-6.0	0.15-0.17	7.4-9.0	<2	Low----------	0.49	5	3
	3-30	8-18	2.0-6.0	0.10-0.18	7.9-9.0	<2	Low----------	0.43		
	30-84	20-30	0.2-0.6	0.14-0.16	7.9-9.0	<2	Moderate-----	0.28		
Monue-----------	0-2	10-15	0.6-6.0	0.14-0.16	7.4-8.4	<2	Low----------	0.28	5	3
	2-84	10-20	0.6-6.0	0.15-0.17	7.4-8.4	<2	Low----------	0.28		
24: Penistaja-------	0-2	10-20	0.6-2.0	0.13-0.15	6.6-8.4	<2	Low----------	0.28	5	3
	2-18	20-30	0.6-2.0	0.15-0.18	6.6-8.4	<2	Low----------	0.32		
	18-58	15-25	2.0-6.0	0.12-0.15	6.6-8.4	<2	Low----------	0.28		
	58-84	5-10	6.0-20	0.04-0.07	6.6-8.4	<2	Low----------	0.20		
Begay-----------	0-4	5-15	0.6-2.0	0.14-0.17	7.4-8.4	<2	Low----------	0.32	5	3
	4-57	5-15	2.0-6.0	0.12-0.15	7.4-8.4	<2	Low----------	0.32		
	57-84	5-10	6.0-20	0.07-0.10	7.4-8.4	<2	Low----------	0.17		
25--------------- Polacca	0-3	20-30	0.2-0.6	0.16-0.19	7.4-8.4	<2	Moderate-----	0.28	5	4L
	3-33	22-30	0.06-0.2	0.15-0.18	7.4-8.4	<2	Moderate-----	0.24		
	33-84	3-8	6.0-20	0.05-0.08	7.4-8.4	<2	Low----------	0.10		
26--------------- Querencia	0-1	20-35	0.6-2.0	0.13-0.15	7.4-8.4	<2	Moderate-----	0.32	---	---
	1-33	15-30	0.6-2.0	0.15-0.17	7.4-8.4	<2	Low----------	0.37		
	33-84	15-25	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low----------	0.37		
27. Rock outcrop										
28: Rock outcrop.										
Torriorthents.										
29--------------- Sheppard	0-1	3-5	6.0-20	0.04-0.06	7.4-8.4	<2	Low----------	0.10	5	1
	1-84	3-8	6.0-20	0.04-0.07	7.4-8.4	<2	Low----------	0.15		
30--------------- Sheppard	0-1	3-5	2.0-20	0.05-0.07	7.4-8.4	<2	Low----------	0.10	5	2
	1-84	3-8	2.0-20	0.05-0.08	7.9-9.0	<2	Low----------	0.15		
31--------------- Sheppard	0-2	5-8	6.0-20	0.06-0.08	7.4-8.4	<2	Low----------	0.15	5	2
	2-84	1-10	6.0-20	0.05-0.08	7.4-8.4	<2	Low----------	0.15		

TABLE 11.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	In/hr	In/in	pH	mmhos/cm				
32:										
Sheppard	0-2	5-8	6.0-20	0.06-0.08	7.4-8.4	<2	Low	0.15	5	2
	2-84	1-10	6.0-20	0.05-0.08	7.4-8.4	<2	Low	0.15		
Monue	0-5	10-15	0.6-6.0	0.14-0.16	7.4-8.4	<2	Low	0.28	5	3
	5-84	10-20	2.0-6.0	0.12-0.16	7.9-9.0	<2	Low	0.28		
33:										
Sheppard	0-9	5-8	6.0-20	0.06-0.08	7.4-8.4	<2	Low	0.15	5	2
	9-84	1-10	6.0-20	0.05-0.08	7.4-8.4	<2	Low	0.15		
Nakai	0-3	8-18	2.0-6.0	0.15-0.17	7.4-9.0	<2	Low	0.49	5	3
	3-84	8-18	2.0-6.0	0.10-0.18	7.9-9.0	<2	Low	0.43		
34:										
Sheppard	0-2	3-5	2.0-20	0.05-0.07	7.4-8.4	<2	Low	0.10	5	2
	2-84	3-8	2.0-20	0.05-0.08	7.9-9.0	<2	Low	0.15		
Torriorthents.										
35:										
Strych	0-2	10-20	2.0-6.0	0.03-0.05	7.4-8.4	<2	Low	0.05	5	8
	2-9	7-20	0.6-6.0	0.07-0.09	7.9-8.4	<2	Low	0.10		
	9-23	10-20	2.0-6.0	0.06-0.10	7.9-8.4	<2	Low	0.10		
	23-60	10-20	2.0-6.0	0.03-0.05	7.9-9.0	<2	Low	0.05		
Rock outcrop.										
36 Tewa	0-1	15-20	0.6-2.0	0.14-0.16	7.4-7.8	<2	Low	0.37	5	3
	1-25	25-35	0.2-0.6	0.15-0.19	7.4-8.4	<2	Low	0.32		
	25-31	10-20	0.6-2.0	0.13-0.15	7.4-8.4	<2	Low	0.32		
	31-84	25-35	0.2-0.6	0.15-0.19	7.4-8.4	<2	Low	0.32		
37. Torrifluvents										
38:										
Travessilla	0-1	7-11	0.6-2.0	0.14-0.17	7.4-8.4	<2	Low	0.32	1	3
	1-11	9-14	2.0-6.0	0.13-0.15	7.4-8.4	<2	Low	0.28		
	11-15	---	---	---	---	---	---	----		
Rock outcrop.										
39. Typic Torriorthents										
40. Ustic Torriorthents										
41 Uzona	0-1	20-27	0.6-2.0	0.04-0.07	7.4-8.4	8-16	Moderate	0.37	5	4L
	1-45	35-55	<0.06	0.03-0.06	7.9-9.0	>16	High	0.32		
	45-58	20-30	0.2-0.6	0.03-0.05	>8.4	>16	Moderate	0.28		
	58-84	5-10	6.0-20	0.01-0.02	>8.4	>16	Low	0.10		
42 Wepo	0-3	35-40	0.06-0.2	0.18-0.20	7.4-8.4	<2	High	0.32	5	4
	3-32	35-45	0.06-0.2	0.14-0.17	7.4-8.4	2-8	High	0.32		
	32-84	35-45	0.06-0.2	0.14-0.17	7.4-8.4	2-8	High	0.28		

TABLE 12.--SOIL AND WATER FEATURES

("Flooding" and "bedrock" and terms such as "rare" and "brief" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Hardness	Uncoated steel	Concrete
					In			
1 Bacobi	C	None	---	---	20-39	Soft	High	Low.
2: Badland.								
Torriorthents.								
3 Bighams	B	None	---	---	24-40	Soft	High	Low.
4 Cannonville	D	None	---	---	7-20	Soft	High	Moderate.
5: Doak	B	None	---	---	40-60	Soft	High	Low.
Monue	B	None	---	---	>60	---	High	Low.
6. Dune land								
7 Epikom	D	None	---	---	10-20	Hard	High	Low.
8 Hano	C	None	---	---	40-55	Soft	High	Low.
9 Ives	B	Frequent	Brief	Jul-Sep	>60	---	High	High.
10 Jeddito	C	None	---	---	>60	---	High	Low.
11 Jocity	C	Occasional	Brief	Jul-Sep	>60	---	High	Low.
12 Jocity	C	Frequent	Brief	Jul-Sep	>60	---	High	Low.
13 Jocity	B	Occasional	Brief	Jul-Sep	>60	---	High	Moderate.
14 Joraibi	B	Occasional	Very brief	Jul-Sep	>60	---	High	Moderate.
15: Kinan	B	None	---	---	>60	---	High	Low.
Kinan	B	None	---	---	>60	---	High	Low.
16: Kydestea	D	None	---	---	4-19	Hard	High	Low.
Zyme	D	None	---	---	6-20	Soft	High	Low.

TABLE 12.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Hardness	Uncoated steel	Concrete
					In			
16:								
Tonalea----------	C	None--------	---	---	20-39	Hard------	High-----	Low.
17---------------- Mido	A	None--------	---	---	>60	---	High-----	Moderate.
18:								
Mido-------------	A	None--------	---	---	>60	---	High-----	Moderate.
Begay------------	B	None--------	---	---	>60	---	High-----	Low.
19:								
Milok------------	B	None--------	---	---	40-60	Soft------	High-----	Low.
Mido-------------	A	None--------	---	---	>60	---	High-----	Moderate.
20---------------- Monue	B	None--------	---	---	>60	---	High-----	Low.
21---------------- Naha	C	None--------	---	---	>60	---	High-----	Low.
22---------------- Nakai	B	None--------	---	---	40-60	Hard------	High-----	Moderate.
23:								
Nakai------------	B	None--------	---	---	>60	---	High-----	Moderate.
Monue------------	B	None--------	---	---	>60	---	High-----	Low.
24:								
Penistaja--------	B	None--------	---	---	>60	---	High-----	Low.
Begay------------	B	None--------	---	---	>60	---	High-----	Low.
25---------------- Polacca	C	Rare--------	---	---	>60	---	High-----	Low.
26---------------- Querencia	B	Rare--------	---	---	>60	---	Moderate	Low.
27. Rock outcrop								
28:								
Rock outcrop.								
Torriorthents.								
29, 30, 31-------- Sheppard	A	None--------	---	---	>60	---	High-----	Low.
32:								
Sheppard---------	A	None--------	---	---	>60	---	High-----	Low.
Monue------------	B	None--------	---	---	>60	---	High-----	Low.
33:								
Sheppard---------	A	None--------	---	---	>60	---	High-----	Low.
Nakai------------	B	None--------	---	---	>60	---	High-----	Moderate.

TABLE 12.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Hardness	Uncoated steel	Concrete
					In			
34:								
Sheppard---------	A	None--------	---	---	>60	---	High-----	Low.
Torriorthents.								
35:								
Strych-----------	B	None--------	---	---	>60	---	High-----	Moderate.
Rock outcrop.								
36---------------- Tewa	B	Rare--------	---	---	>60	---	High-----	Low.
37. Torrifluvents								
38:								
Travessilla------	D	None--------	---	---	6-17	Hard------	High-----	Low.
Rock outcrop.								
39. Typic Torriorthents								
40. Ustic Torriorthents								
41---------------- Uzona	D	Rare--------	---	---	>60	---	High-----	High.
42---------------- Wepo	C	Rare--------	---	---	>60	---	High-----	Low.

TABLE 13.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Bacobi	Fine-loamy, mixed, mesic Typic Haplargids
Begay	Coarse-loamy, mixed, mesic Ustollic Camborthids
Bighams	Fine-loamy, mixed, mesic Ustollic Calciorthids
Cannonville	Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents
*Doak	Fine-loamy, mixed, mesic Typic Haplargids
Epikom	Loamy, mixed, mesic Lithic Camborthids
Hano	Fine, mixed, mesic Ustollic Haplargids
Ives	Coarse-loamy, mixed (calcareous), mesic Typic Torrifluvents
Jeddito	Coarse-loamy, mixed (calcareous), mesic Typic Torriorthents
Jocity	Fine-loamy, mixed (calcareous), mesic Typic Torrifluvents
Joraibi	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Torrifluvents
Kinan	Coarse-loamy, mixed, mesic Typic Calciorthids
Kydestea	Loamy-skeletal, mixed (calcareous), mesic Lithic Ustorthents
Mido	Mixed, mesic Ustic Torripsamments
Milok	Coarse-loamy, mixed, mesic Ustollic Calciorthids
Monue	Coarse-loamy, mixed, mesic Typic Camborthids
Naha	Sandy over loamy, mixed (calcareous), mesic Typic Torriorthents
Nakai	Coarse-loamy, mixed, mesic Typic Calciorthids
Penistaja	Fine-loamy, mixed, mesic Ustollic Haplargids
Polacca	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Camborthids
Querencia	Fine-loamy, mixed, mesic Ustollic Camborthids
Sheppard	Mixed, mesic Typic Torripsamments
Strych	Loamy-skeletal, mixed, mesic Ustollic Calciorthids
Tewa	Fine-loamy, mixed, mesic Typic Camborthids
Tonalea	Mixed, mesic Typic Ustipsamments
Torrifluvents	Torrifluvents
Torriorthents	Torriorthents
Travessilla	Loamy, mixed (calcareous), mesic Lithic Ustic Torriorthents
Typic Torriorthents	Typic Torriorthents
Ustic Torriorthents	Ustic Torriorthents
Uzona	Fine, montmorillonitic, mesic Typic Natrargids
Wepo	Fine, mixed, mesic Vertic Camborthids
Zyme	Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents

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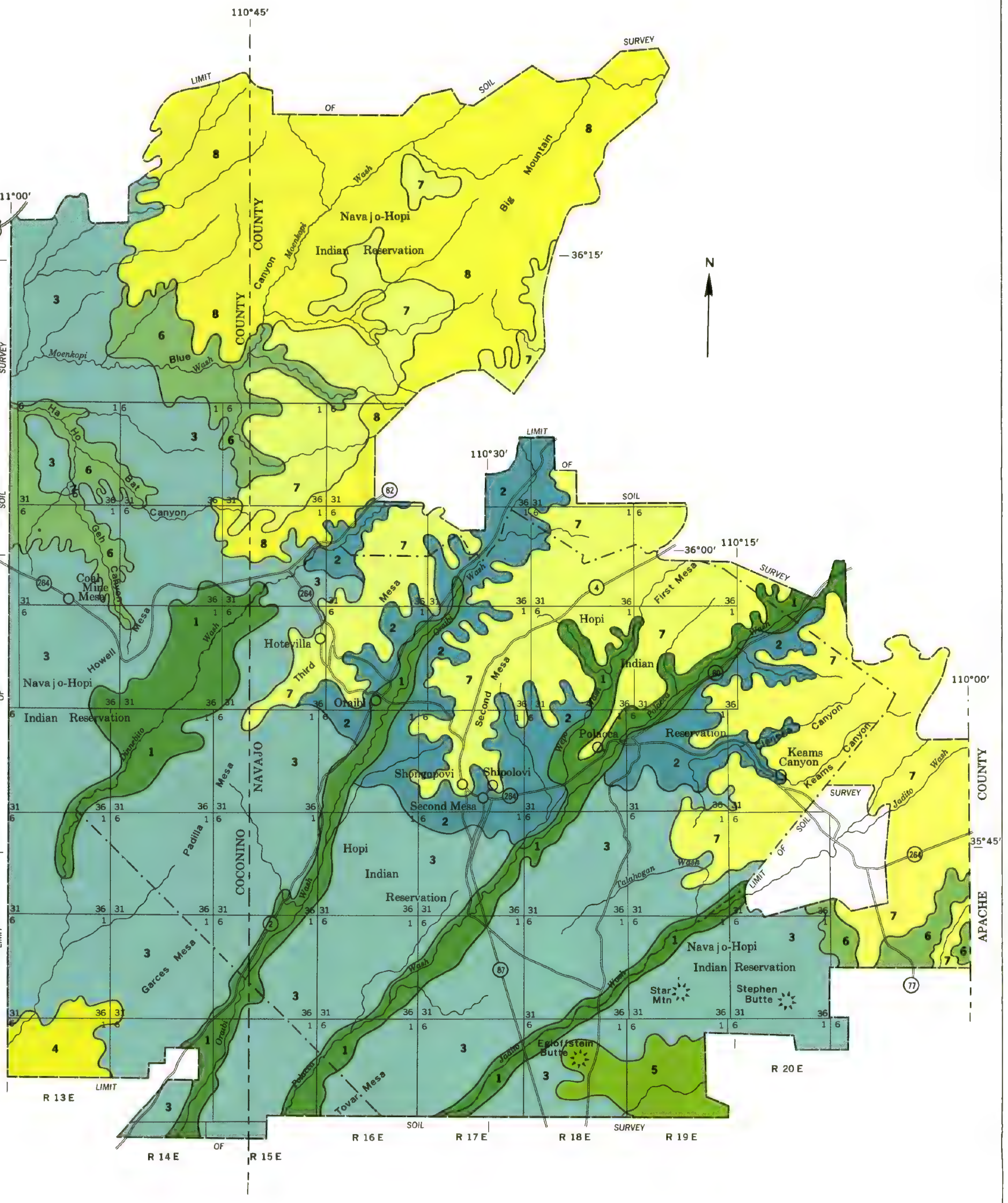
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

MAP UNITS*

- 1 JOCITY-POLACCA-WEPO
- 2 JEDDITO-TEWA
- 3 SHEPPARD-MONUE-NAKAI
- 4 SHEPPARD-JOCITY
- 5 STRYCH-KINAN
- 6 TORRIORTHENTS-BADLAND-ROCK OUTCROP
- 7 BEGAY-PENISTAJA-MIDO
- 8 KYDESTEA-ZYME-TONALEA

*Texture refers to the dominant texture of the subsoil or control section.

COMPILED 1988

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
ARIZONA AGRICULTURAL EXPERIMENT STATION
THE HOPI TRIBE

GENERAL SOIL MAP

HOPI AREA, ARIZONA PARTS OF COCONINO AND NAVAHO COUNTIES

Scale 1:380,160

1 0 1 2 3 4 5 6 Miles

1 0 6 12 Km

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

HOPI AREA, ARIZONA
PARTS OF COCONINO
AND NAVAHO COUNTIES

Scale 1:380,160

1 0 1 2 3 4 5 6 Miles

10 6 12 Km

SOIL LEGEND

SYMBOL	NAME
1	Bacobi fine sandy loam, 1 to 5 percent slopes
2	Badland-Torriorthents complex, 8 to 50 percent slopes
3	Bighams very fine sandy loam, 1 to 8 percent slopes
4	Cannonville clay loam, 15 to 50 percent slopes
5	Doak-Monue complex, 1 to 6 percent slopes
6	Dune land
7	Epikom very gravelly fine sandy loam, 1 to 5 percent slopes
8	Hano fine sandy loam, 2 to 10 percent slopes
9	Ives fine sandy loam, 0 to 2 percent slopes
10	Jeddito loamy sand, 0 to 5 percent slopes
11	Jocity fine sandy loam, 0 to 3 percent slopes
12	Jocity clay loam, 0 to 2 percent slopes
13	Jocity clay loam, sodic, 0 to 2 percent slopes
14	Joraibi clay loam, 0 to 2 percent slopes
15	Kinan complex, 2 to 12 percent slopes
16	Kydestea-Zyme-Tonalea complex, 5 to 50 percent slopes
17	Mido fine sand, 1 to 15 percent slopes
18	Mido-Begay complex, 1 to 8 percent slopes
19	Milok-Mido complex, 1 to 12 percent slopes
20	Monue very fine sandy loam, 1 to 5 percent slopes
21	Naha loamy sand, 0 to 3 percent slopes
22	Nakai fine sandy loam, 3 to 15 percent slopes
23	Nakai-Monue very fine sandy loams, 1 to 5 percent slopes
24	Penistaja-Begay complex, 1 to 8 percent slopes
25	Polacca clay loam, 0 to 3 percent slopes
26	Querencia clay loam, 0 to 3 percent slopes
27	Rock outcrop
28	Rock outcrop-Torriorthents complex, 5 to 60 percent slopes
29	Sheppard sand, 1 to 12 percent slopes
30	Sheppard sand, sodic, 1 to 8 percent slopes
31	Sheppard loamy sand, 1 to 15 percent slopes
32	Sheppard-Monue complex, 1 to 8 percent slopes
33	Sheppard-Nakai complex, 1 to 8 percent slopes
34	Sheppard-Torriorthents complex, 1 to 8 percent slopes
35	Strych-Rock outcrop complex, 25 to 60 percent slopes
36	Tewa very fine sandy loam, 1 to 5 percent slopes
37	Torrifluvents, 0 to 2 percent slopes
38	Travessilla-Rock outcrop complex, 1 to 8 percent slopes
39	Typic Torriorthents, 10 to 35 percent slopes
40	Ustic Torriorthents, 10 to 35 percent slopes
41	Uzona loam, 0 to 2 percent slopes
42	Wepo clay loam, 0 to 3 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool 1/ — Small Airport; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end 2/
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 3 4

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

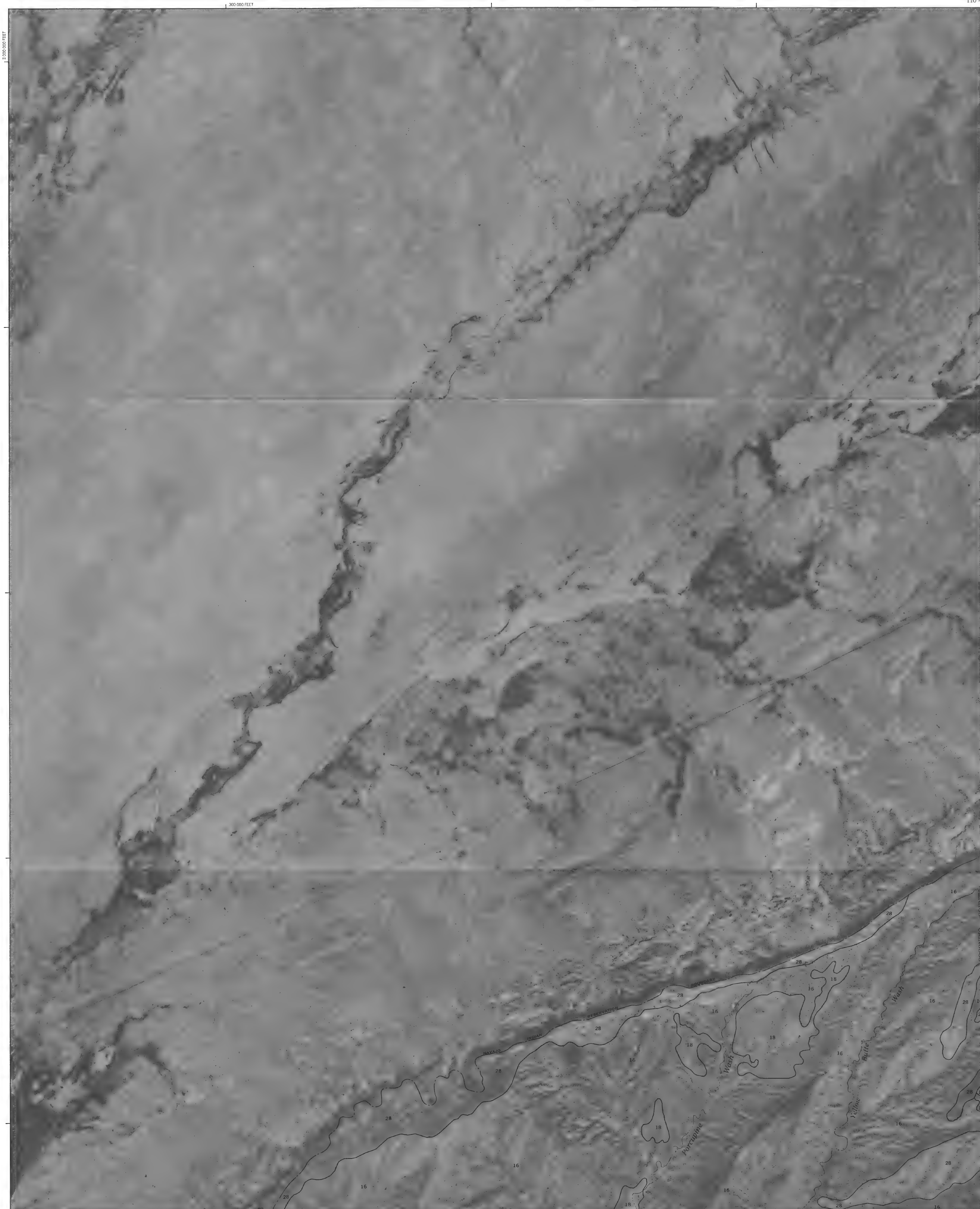
SOIL SAMPLE (normally not shown) — S

MISCELLANEOUS

- Blowout 2/
- Clay spot 2/
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot 2/
- Severely eroded spot 2/
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

1/ Boundary on map sheets to designate areas of traditional and sacred lands where no soil observations were made. Label on maps. "Soil boundaries were plotted by aerial photograph interpretation. No soil observations were made within the outlined area."

2/ Each symbol represents 3 to 6 acres.



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5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000

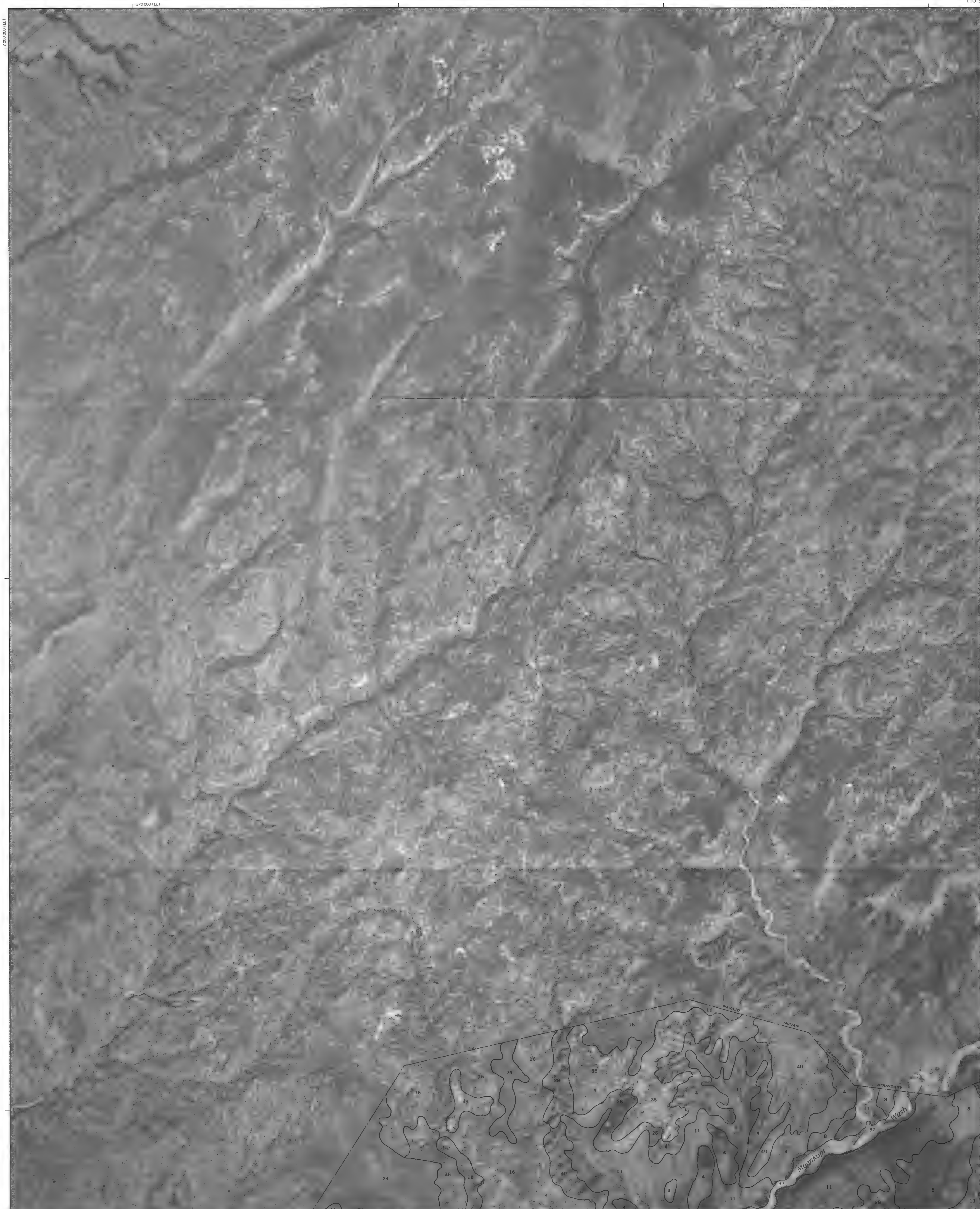
HOPI AREA, ARIZONA NO. 1

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 2

N



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5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers

Scale - 1:24000

HOPI AREA, ARIZONA NO. 3

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 5

N

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 6

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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Scale - 1:24 000
HOPI AREA, ARIZONA NO. 7

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 8
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

(Joins sheet 2) NAVAJO INDIAN RESERVATION BOUNDARY

110°37'30"
36°22'30"

COCONINO COUNTY
NAVAJO COUNTY

(Joins sheet 7)

(Joins sheet 9)

36°15'00"
110°45'00"

(Joins sheet 14)

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 8

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 9

N

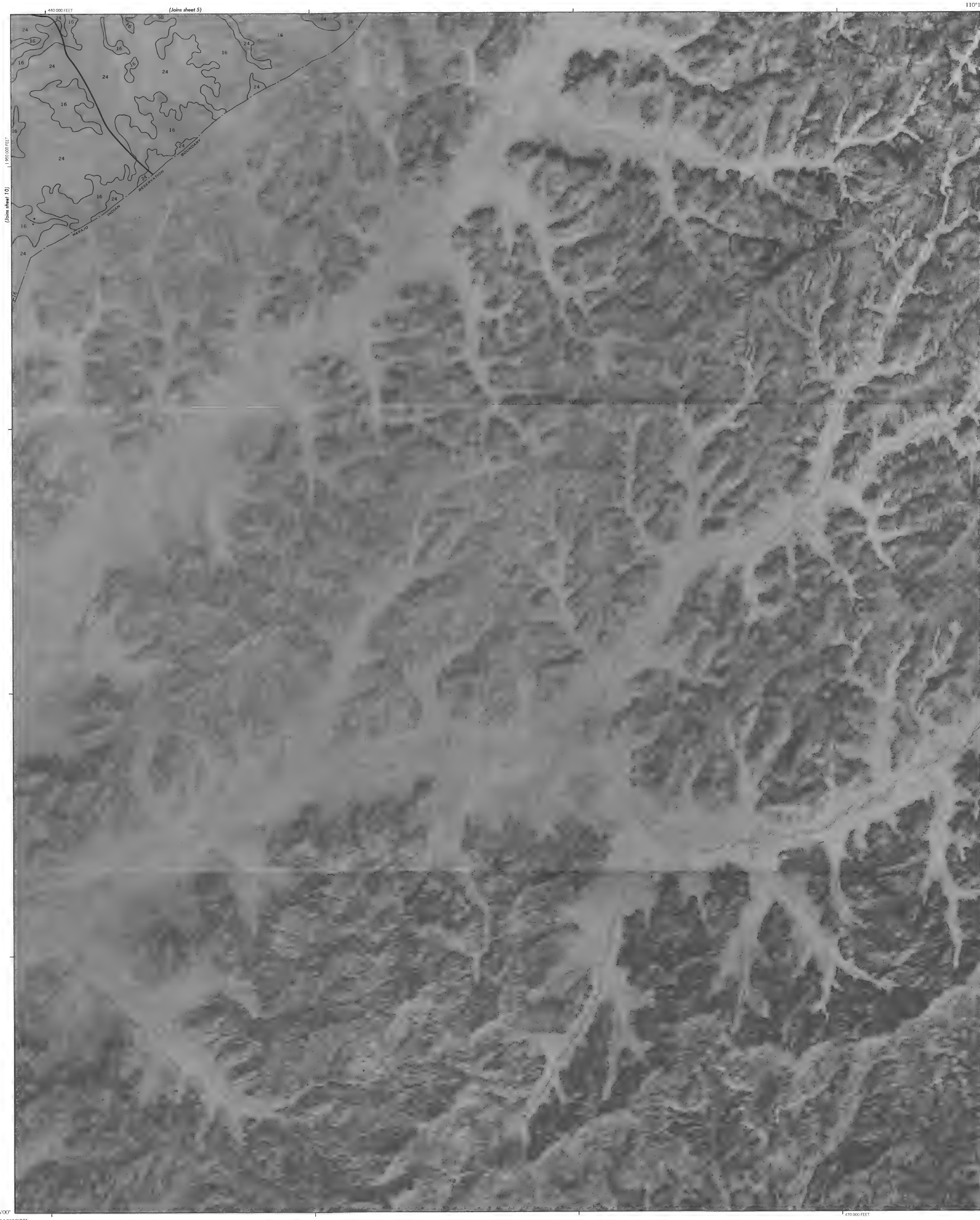
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 10
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 10

N



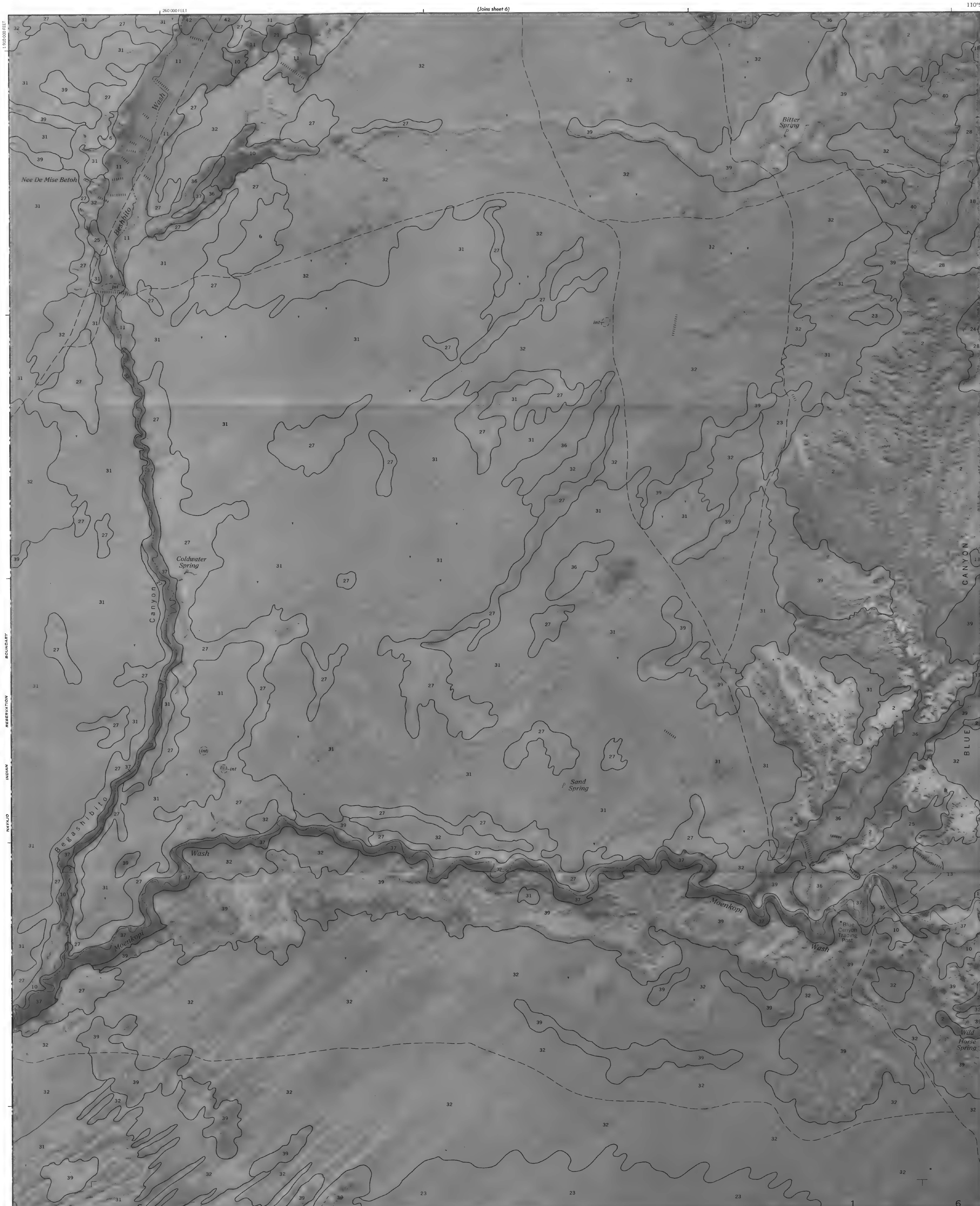
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 11

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 12
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 12

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned

Scale - 1:24 000

HOPI AREA, ARIZONA NO. 13

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO.14
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale 1:24 000
HOPI AREA, ARIZONA NO. 14

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 15
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet

1 .5 0 1 2 3 Kilometers

Scale - 1:24000

HOPI AREA, ARIZONA NO. 15

N

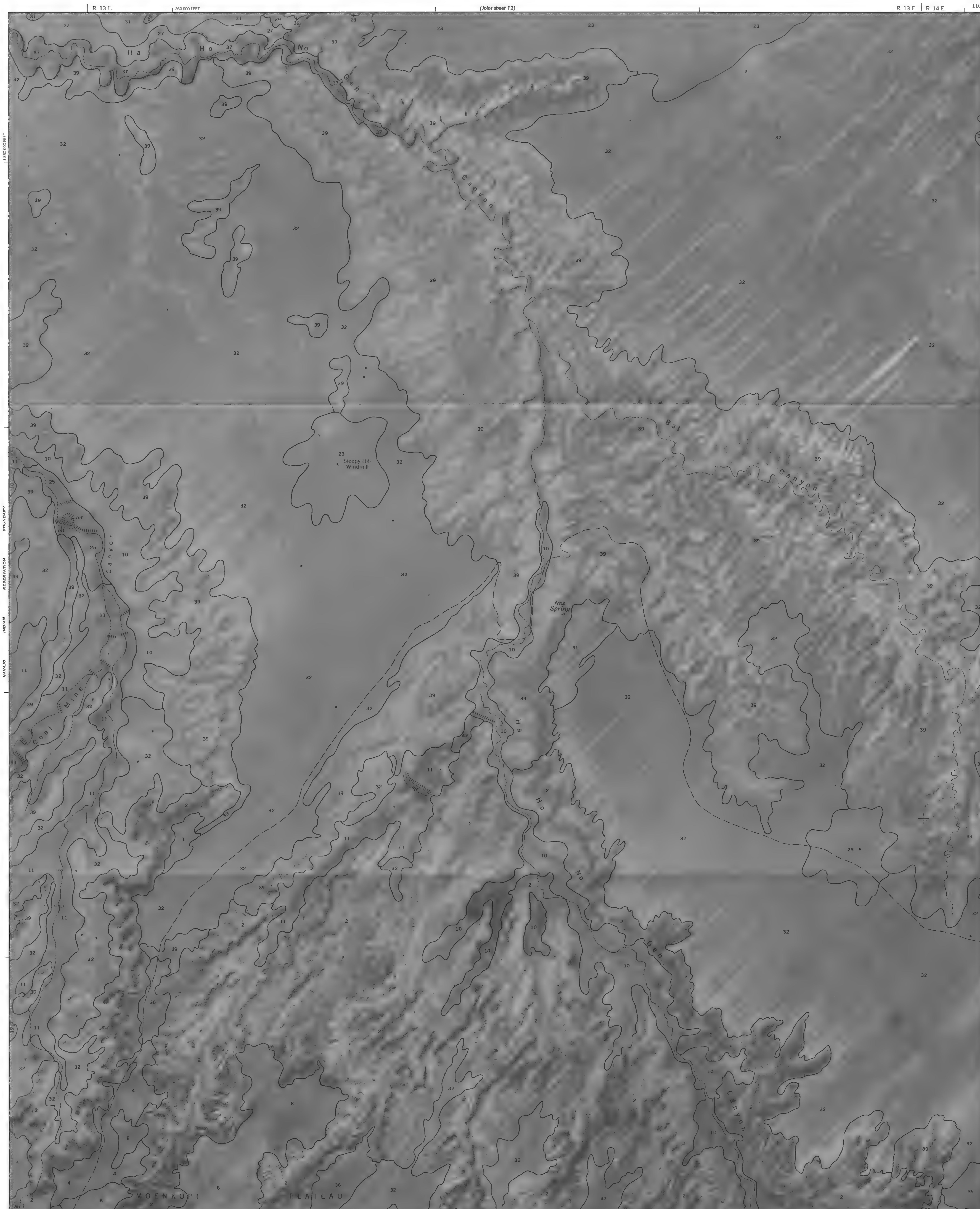
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 16

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 17
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES



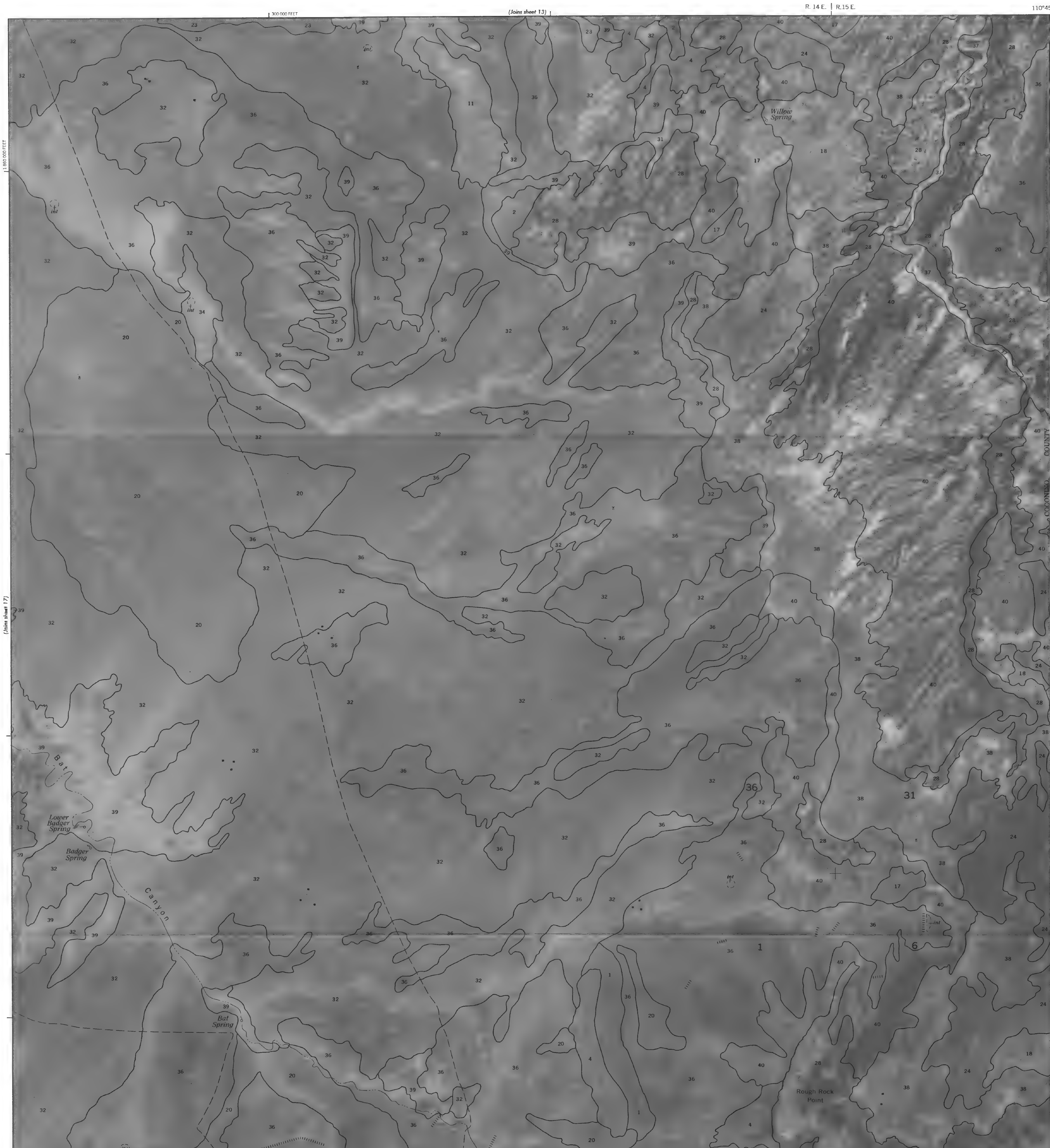
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 17

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO.18
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet

1 .5 0 1 2 3 Kilometers

Scale - 1:24000

N

HOPI AREA, ARIZONA NO. 18

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale 1:24 000
HOPI AREA, ARIZONA NO. 19

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet

1 .5 0 1 2 3 Kilometers

Scale - 1:24000

HOPI AREA, ARIZONA NO. 20

N

HARD ROCKS AZ

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 21

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000

HOPI AREA, ARIZONA NO. 22

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 23

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 24
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 24

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale 1:24 000
HOPI AREA, ARIZONA NO. 25

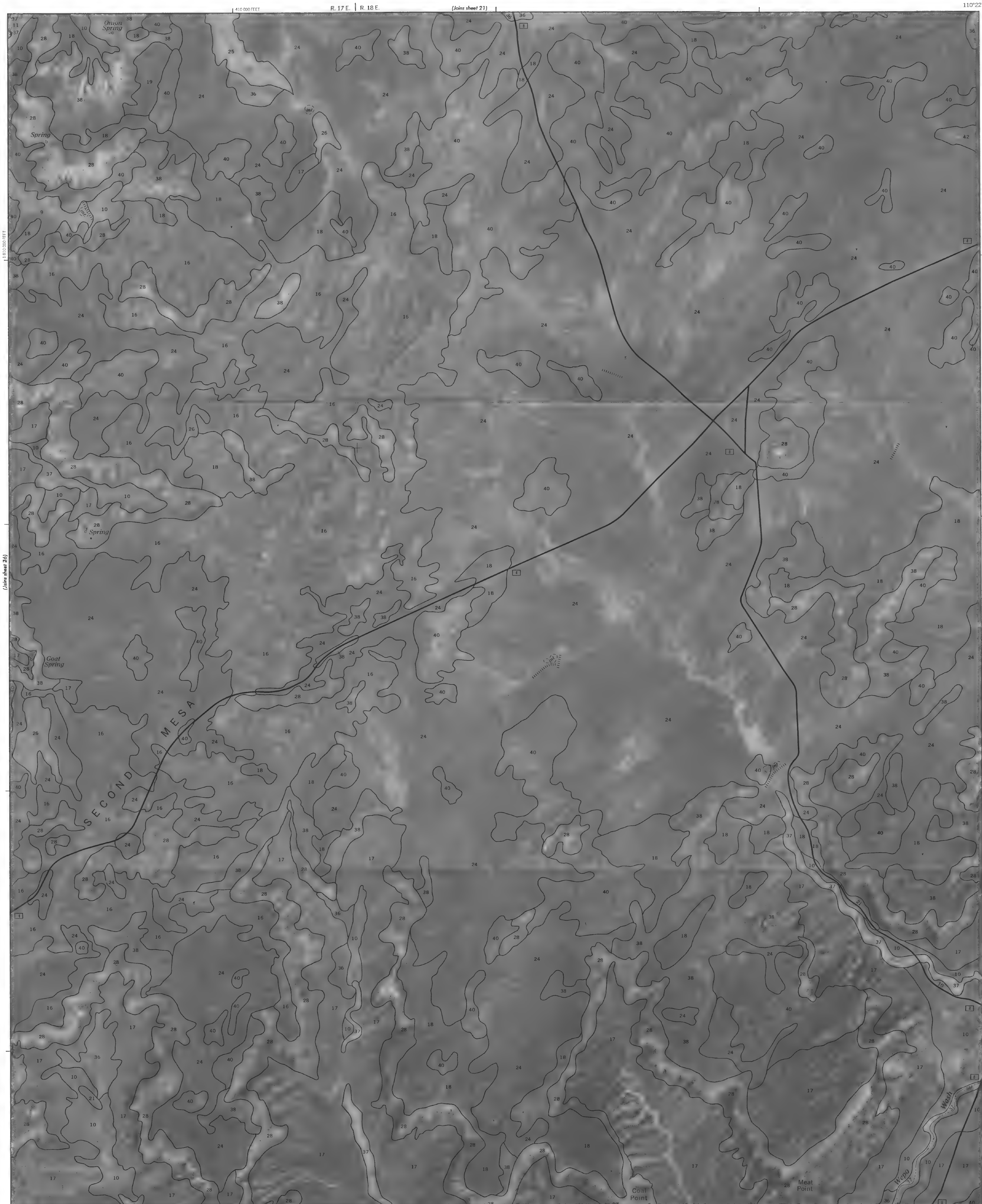
N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale 1:24 000
HOPI AREA, ARIZONA NO. 26

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



POLACCA NW AZ

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000

HOPI AREA, ARIZONA NO. 27

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet

1 .5 0 1 2 3 Kilometers

Scale - 1:24 000

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

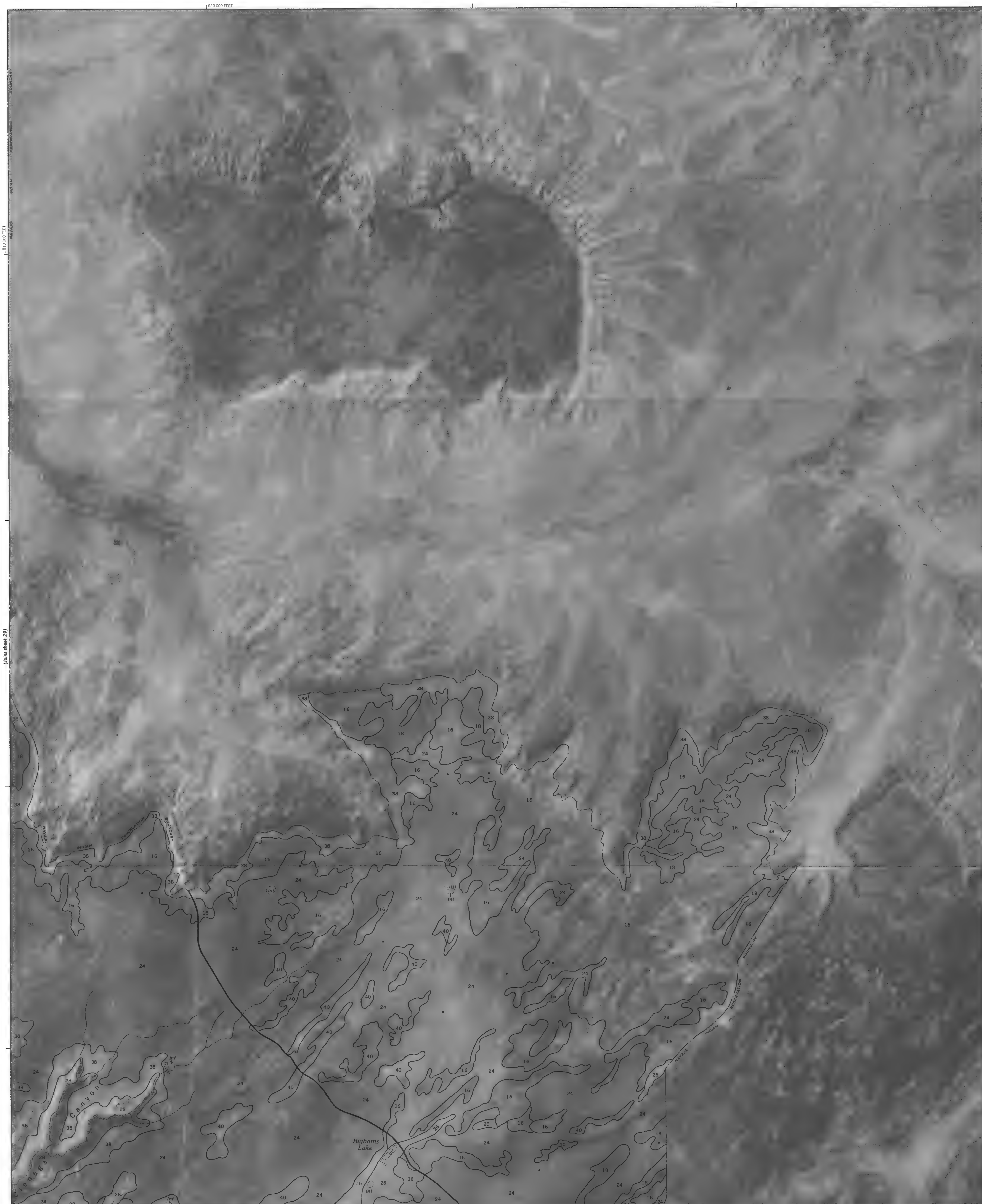
SHEET NO. 29
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000

N

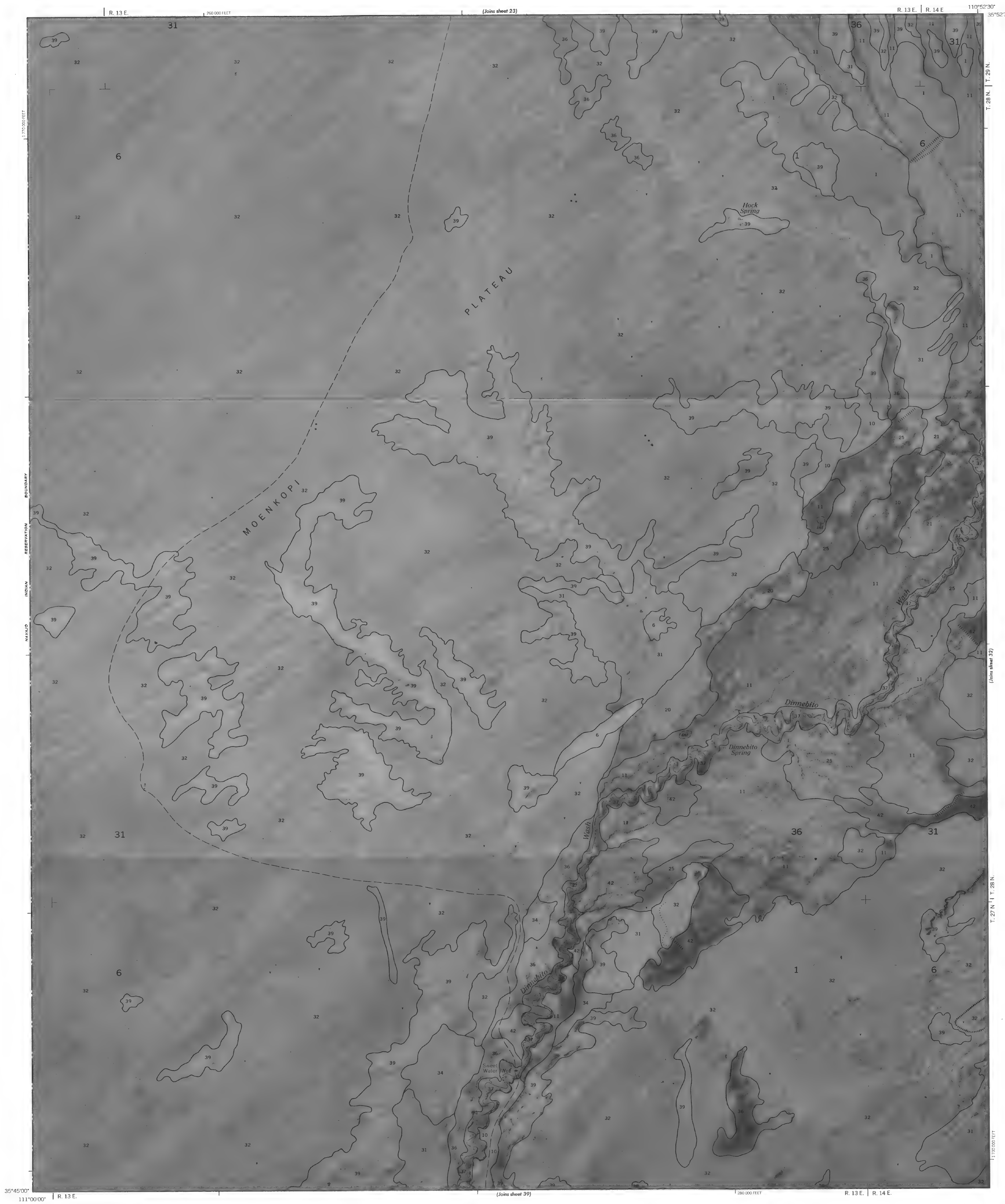
HOPI AREA, ARIZONA NO. 29



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale 1:24000
HOPI AREA, ARIZONA NO. 30

N

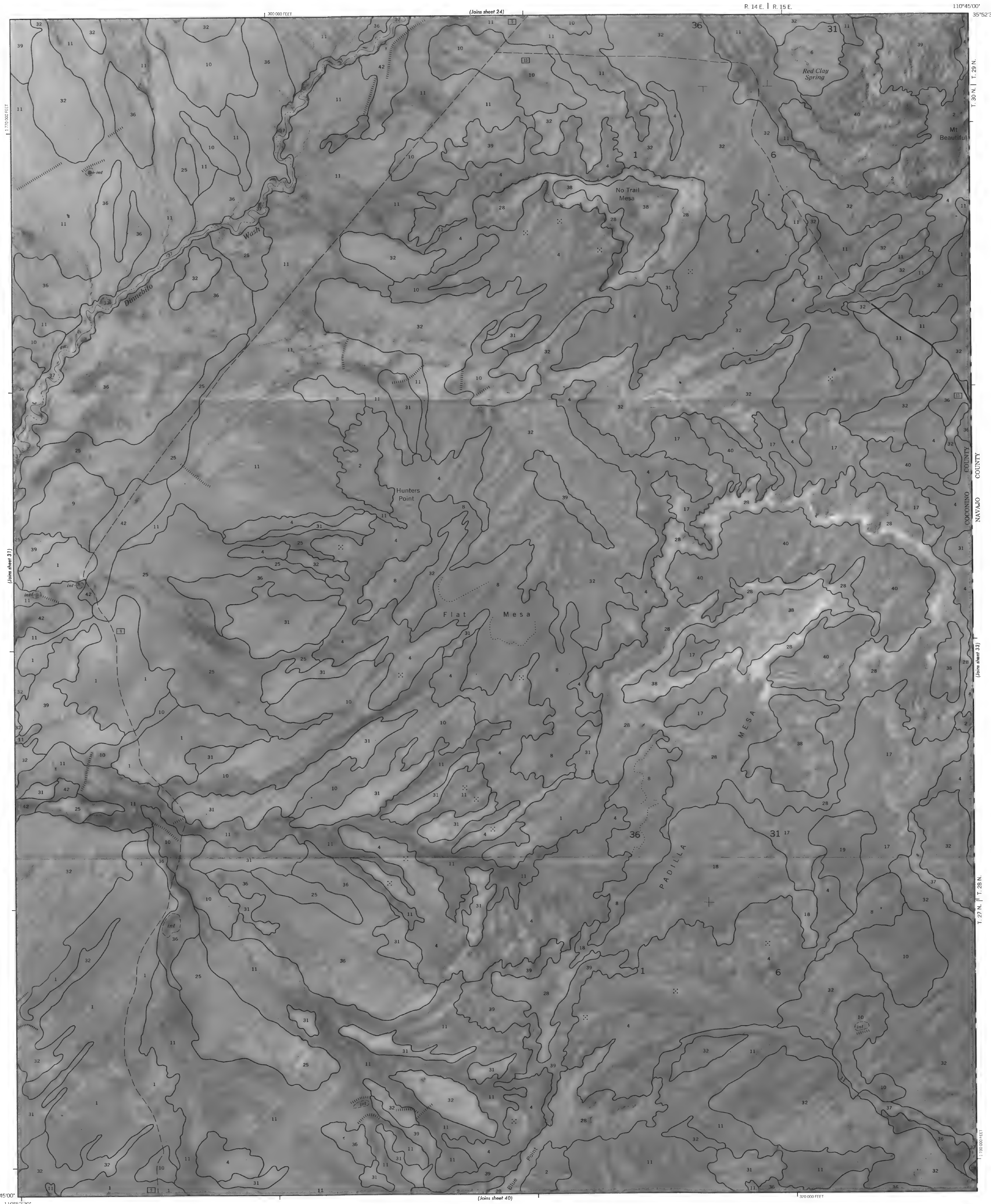


This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000

HOPI AREA, ARIZONA NO. 31

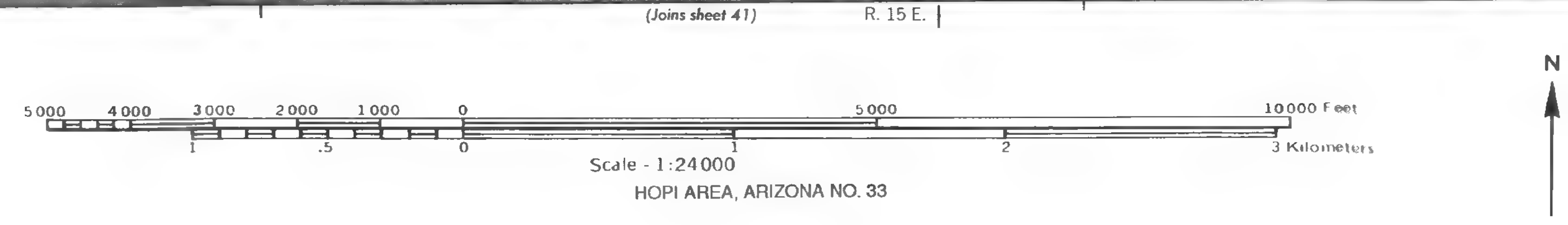
N



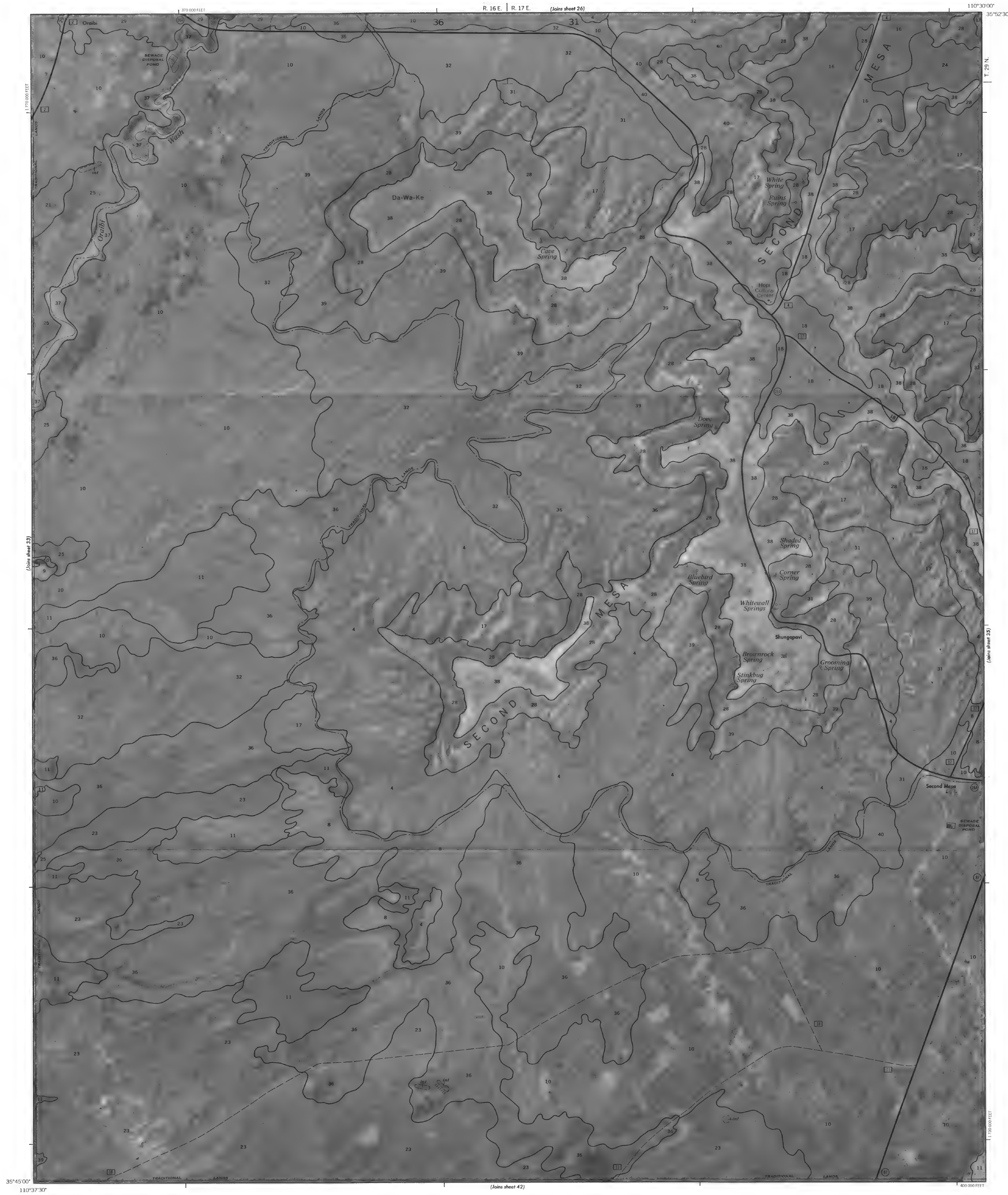
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale 1:24000
HOPI AREA, ARIZONA NO. 32

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



Scale - 1:24000
HOPI AREA, ARIZONA NO. 33

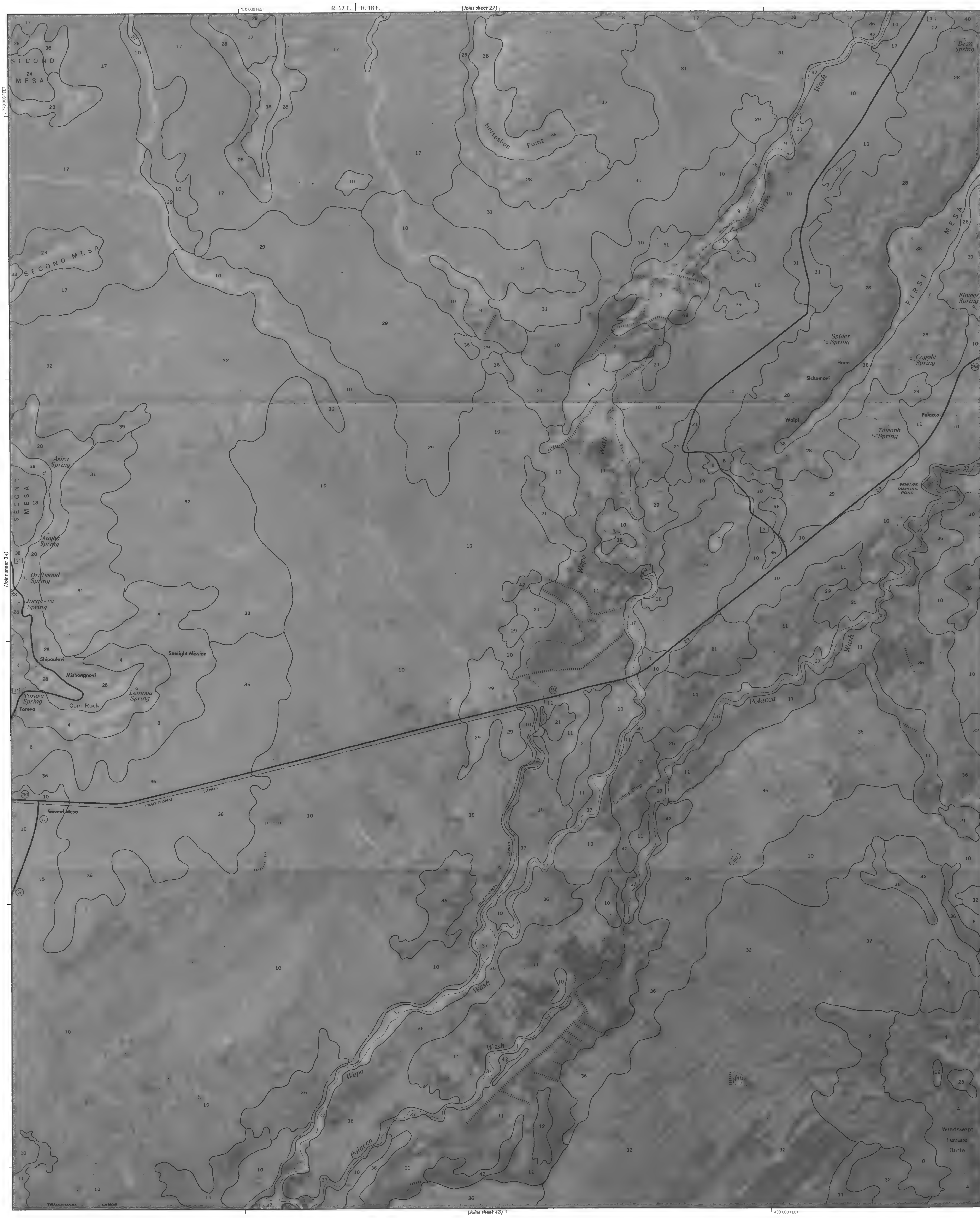


5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000

HOPI AREA, ARIZONA NO. 34

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



POLACCA SW AZ

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 35

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 36
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

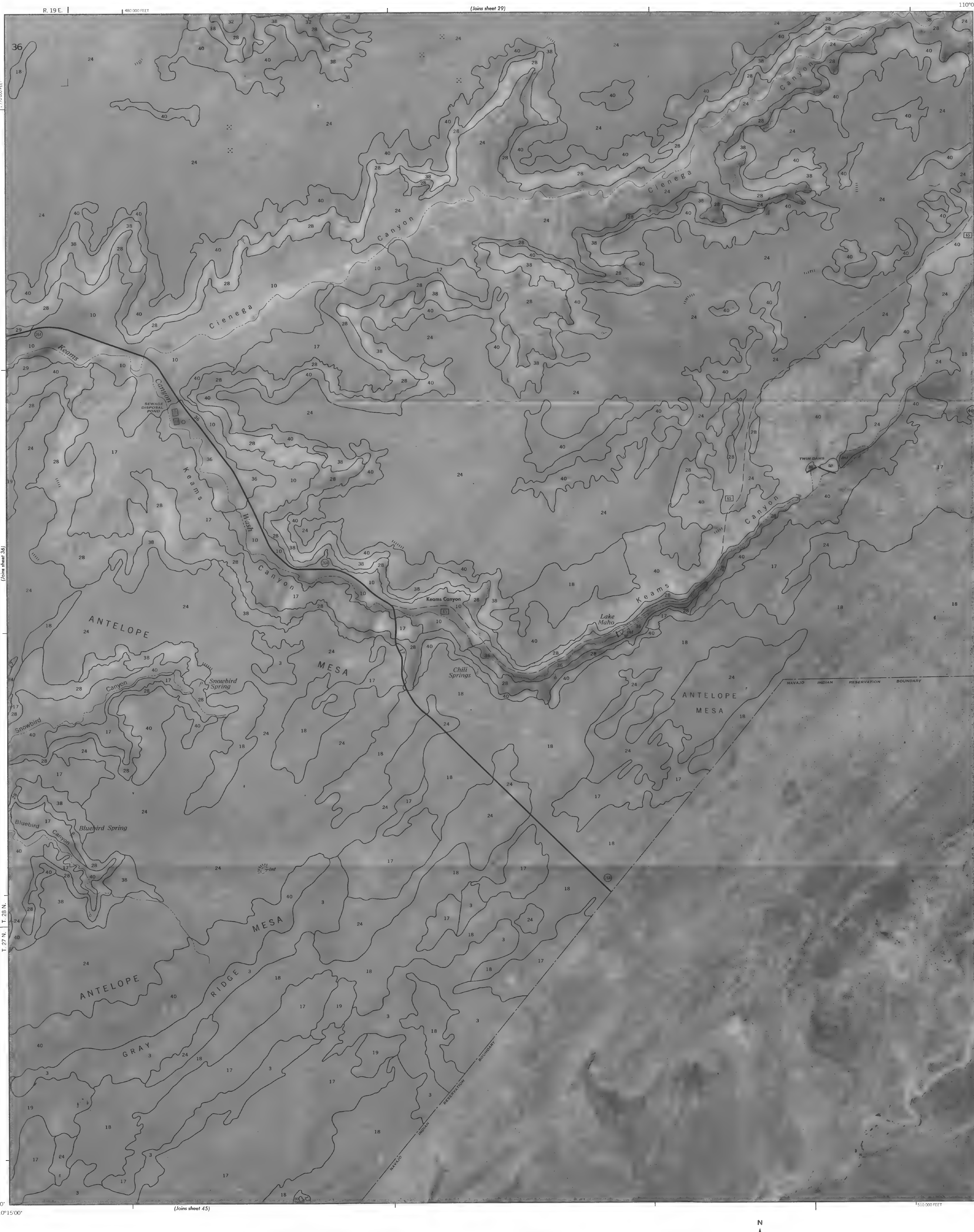
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 36

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 37
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 37

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 38
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

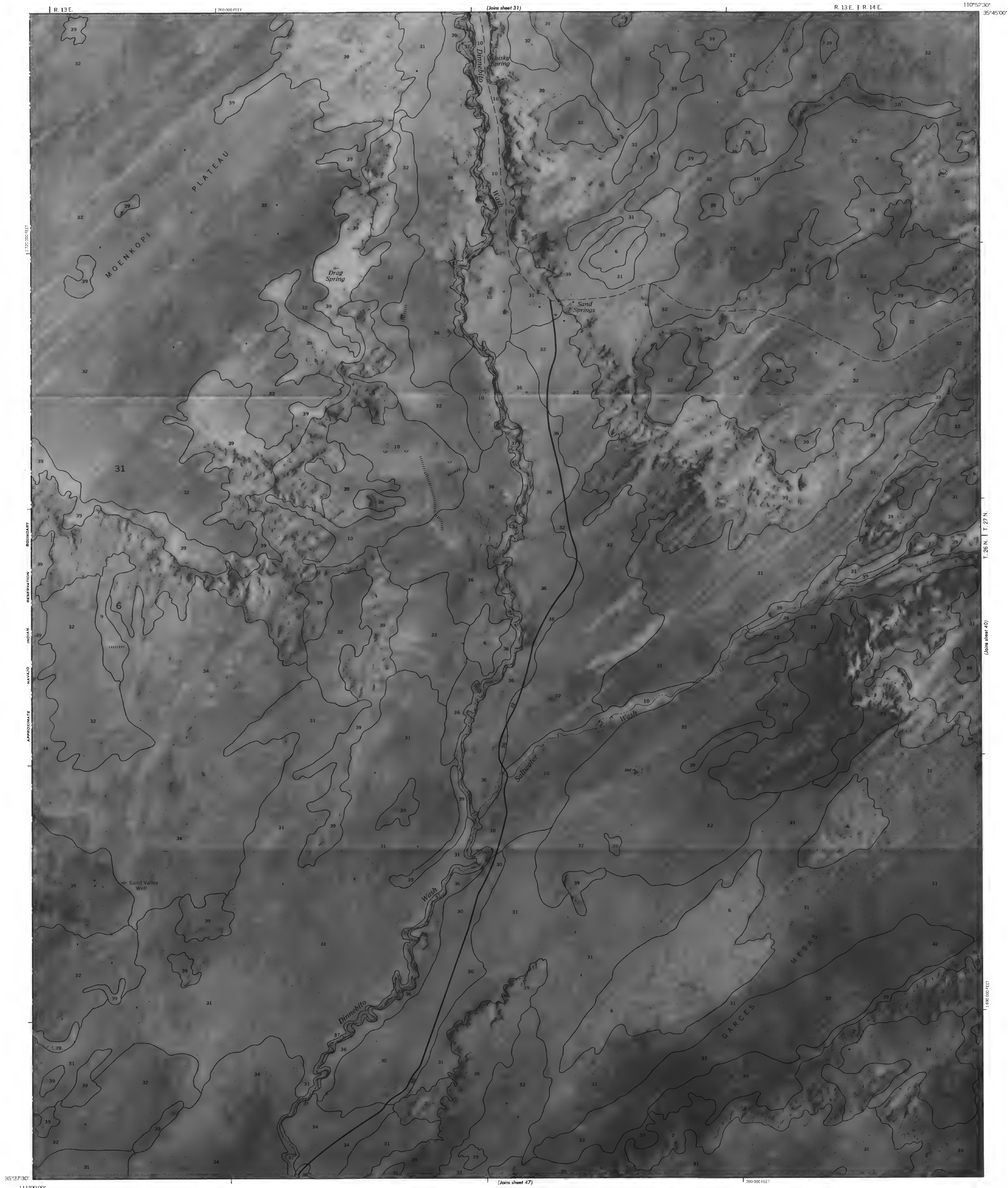
5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

1 .5 0 1 2 3 Kilometers

Scale - 1:24 000

HOPI AREA, ARIZONA NO. 38

N

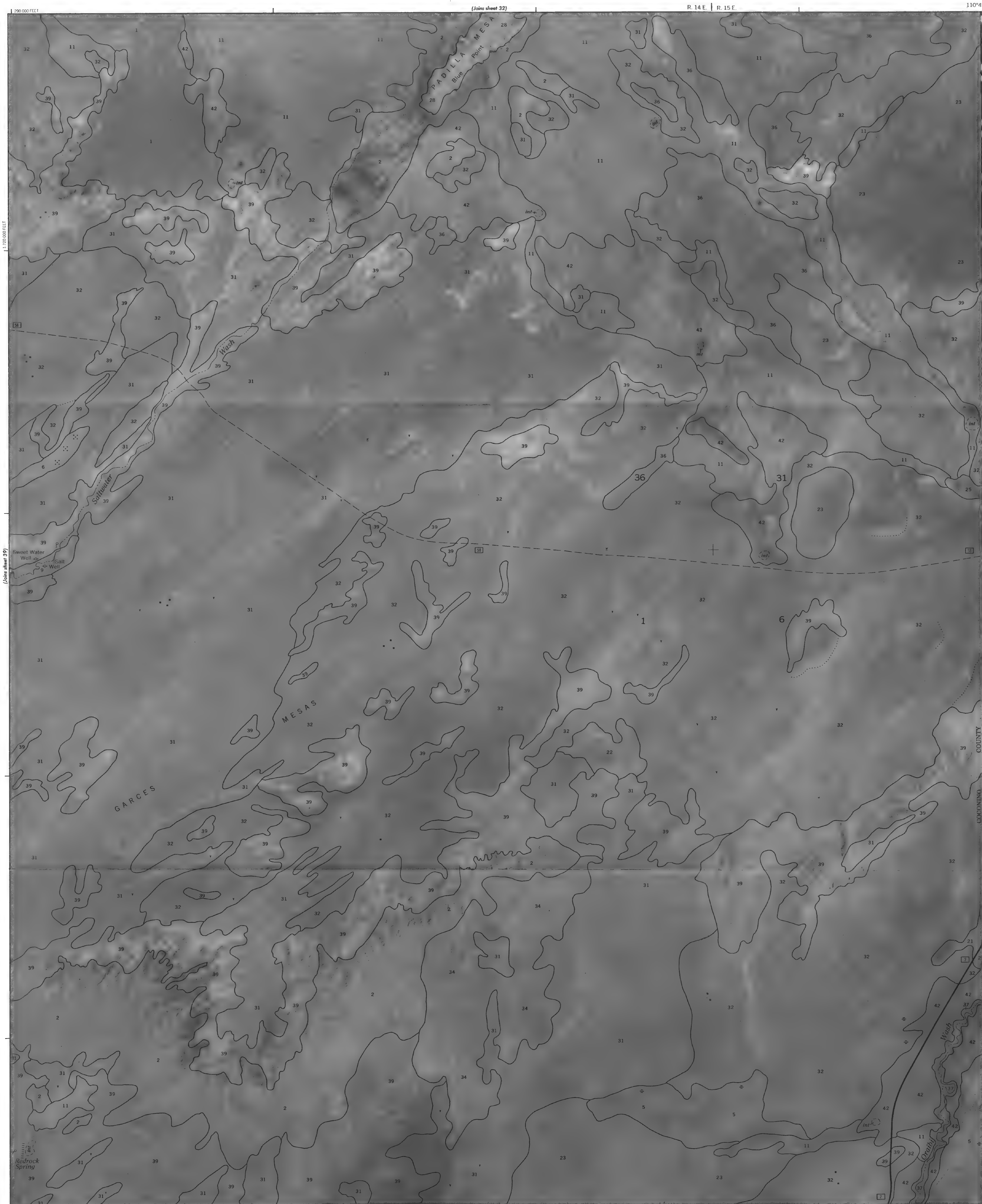


This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000

HOPI AREA, ARIZONA NO. 39

N



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
HOPI AREA, ARIZONA NO. 40

N

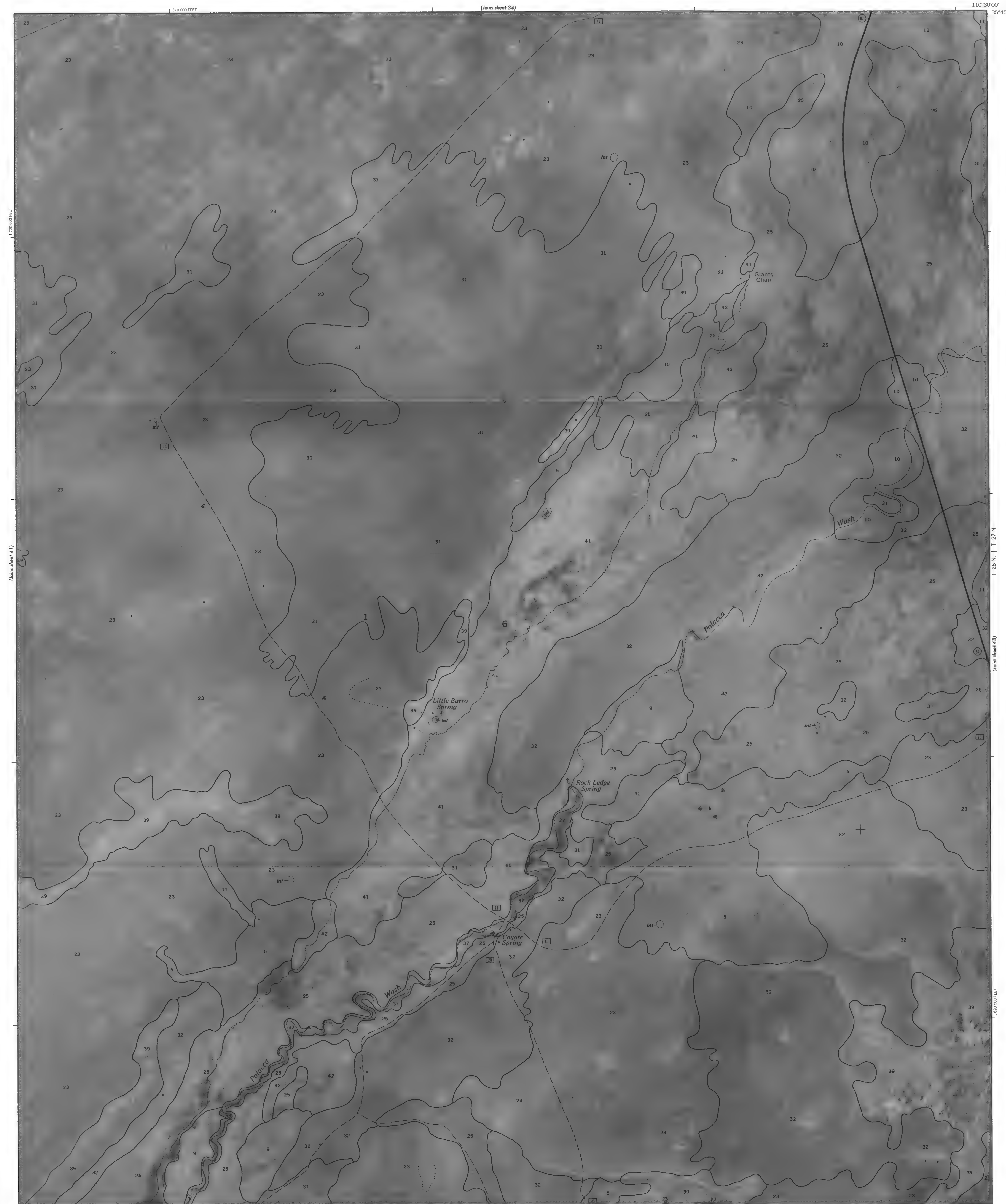
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO.41
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 41

N

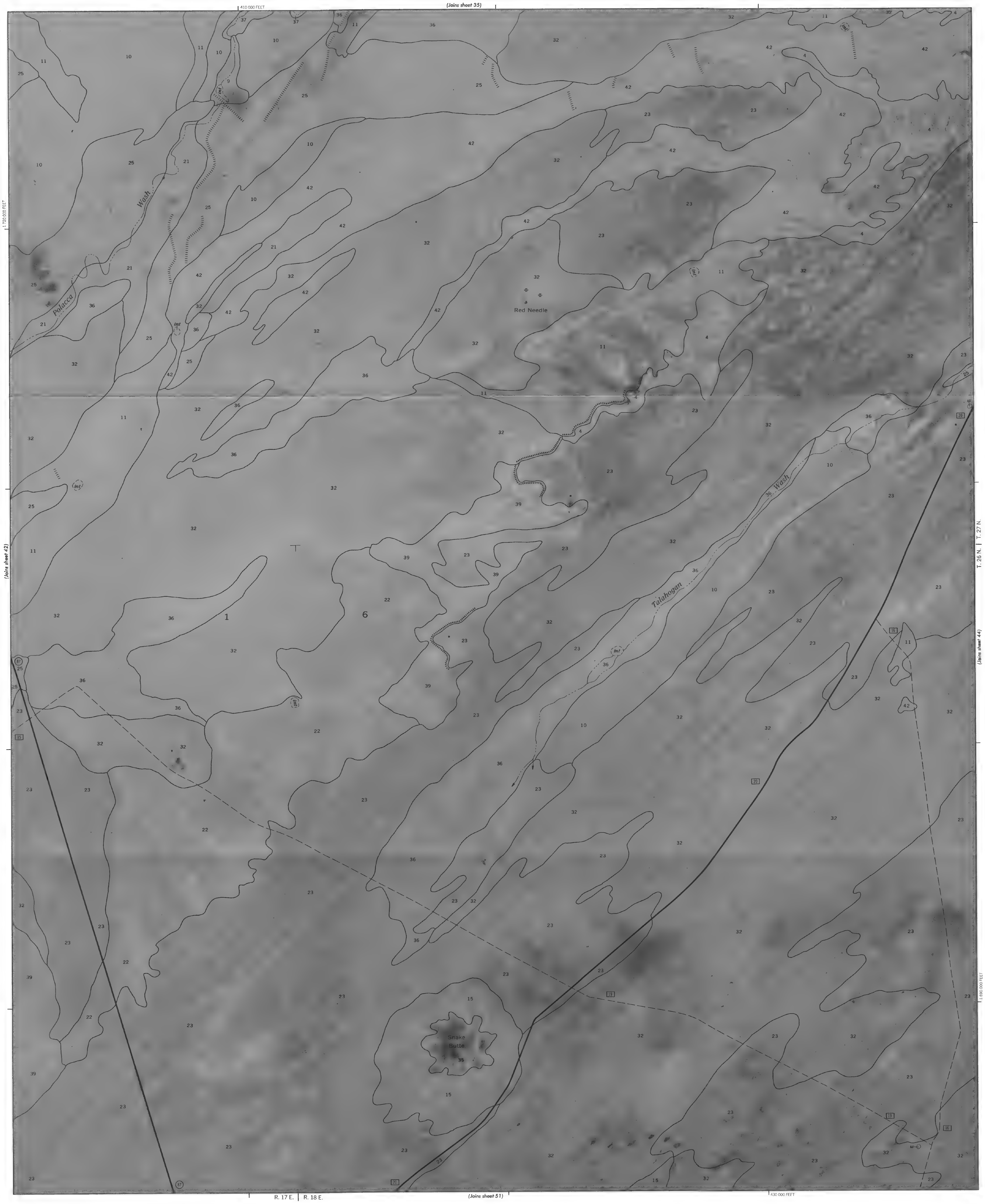


This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000

HOPI AREA, ARIZONA NO. 42

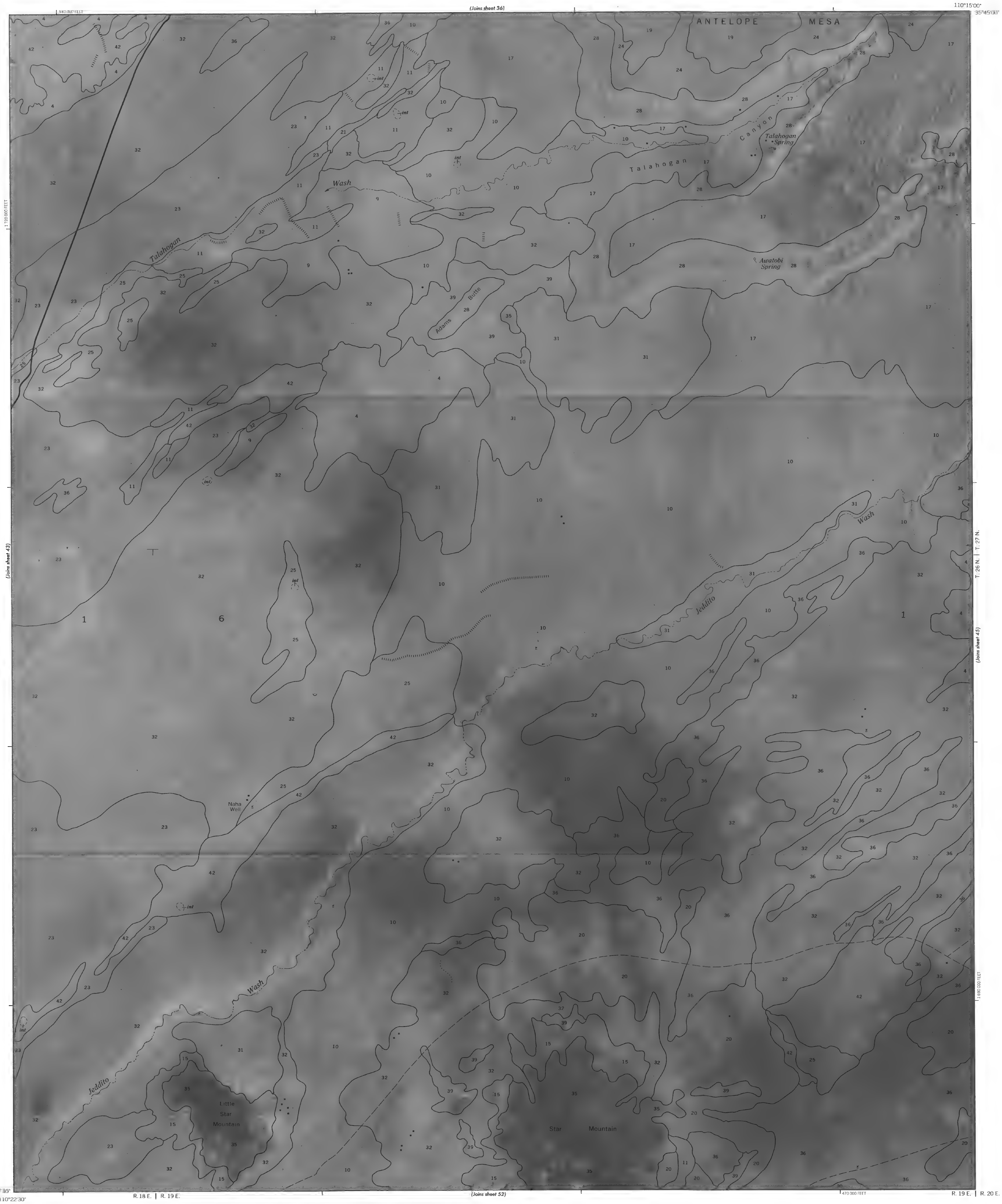
N



5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 43

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet

1 .5 0 1 2 3 Kilometers

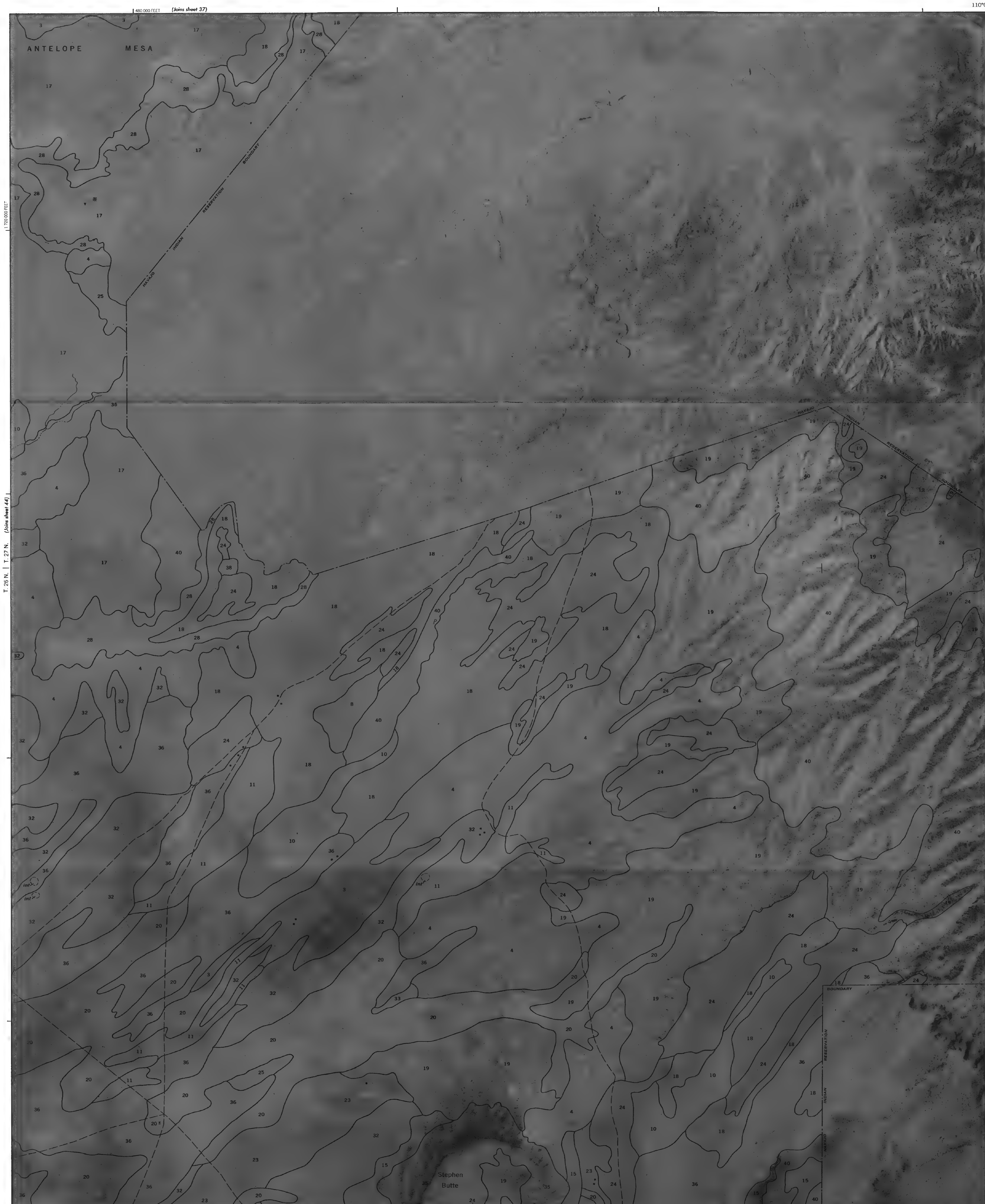
Scale - 1:24000

HOPI AREA, ARIZONA NO. 44

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO.45
SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000

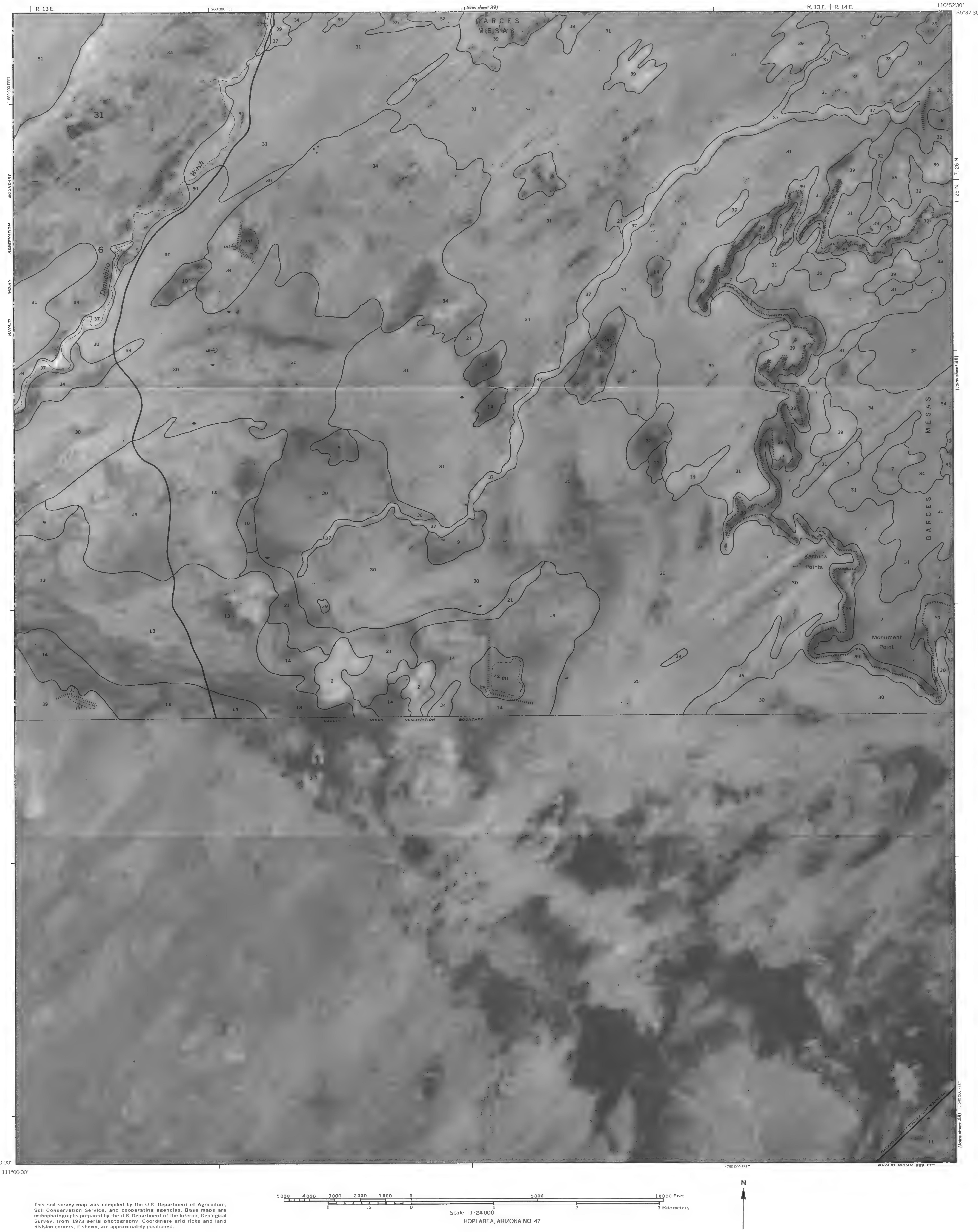
HOPI AREA, ARIZONA NO. 45

N

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

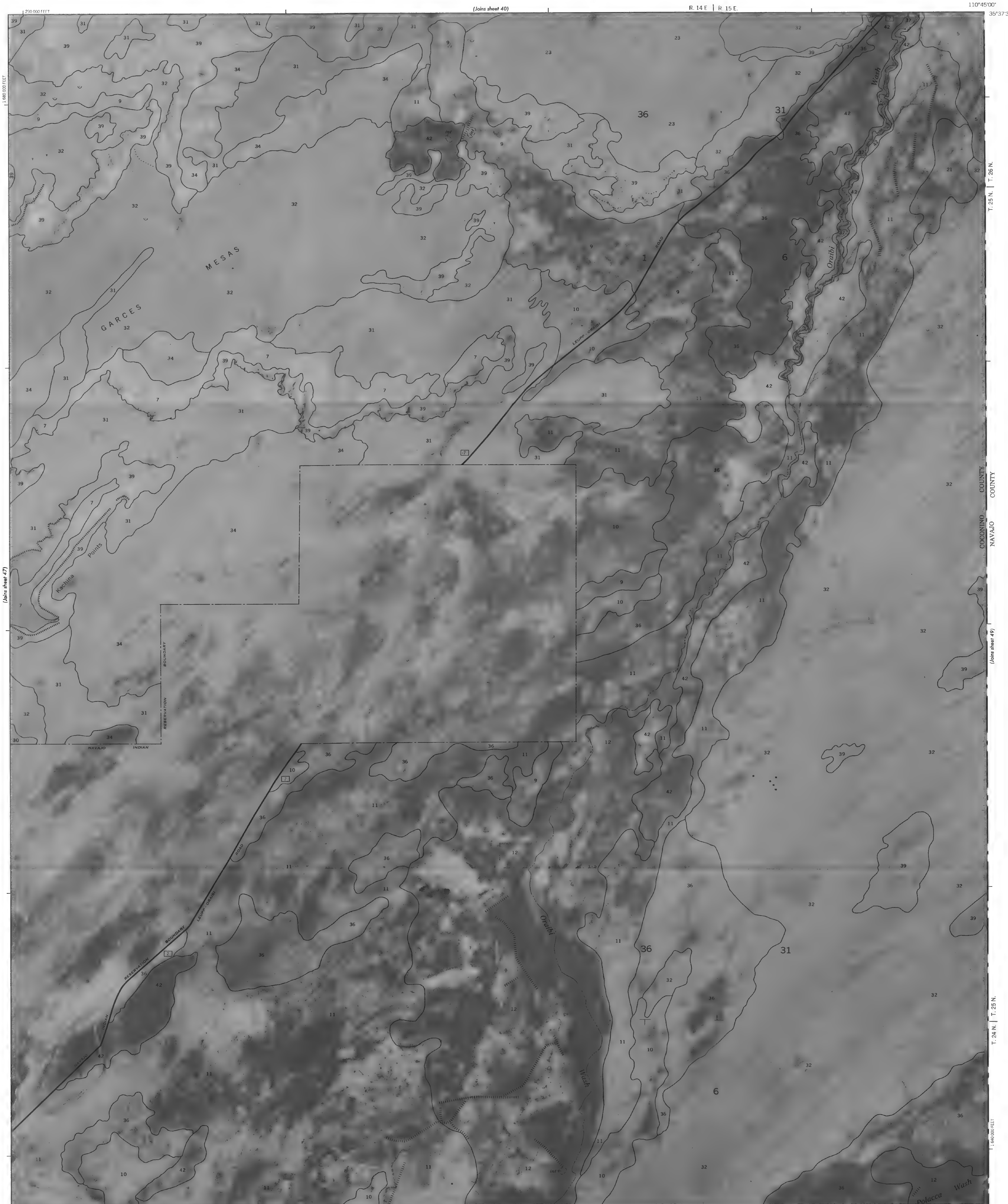
5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 46

N



Scale - 1:24000
HOPI AREA, ARIZONA NO. 47

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

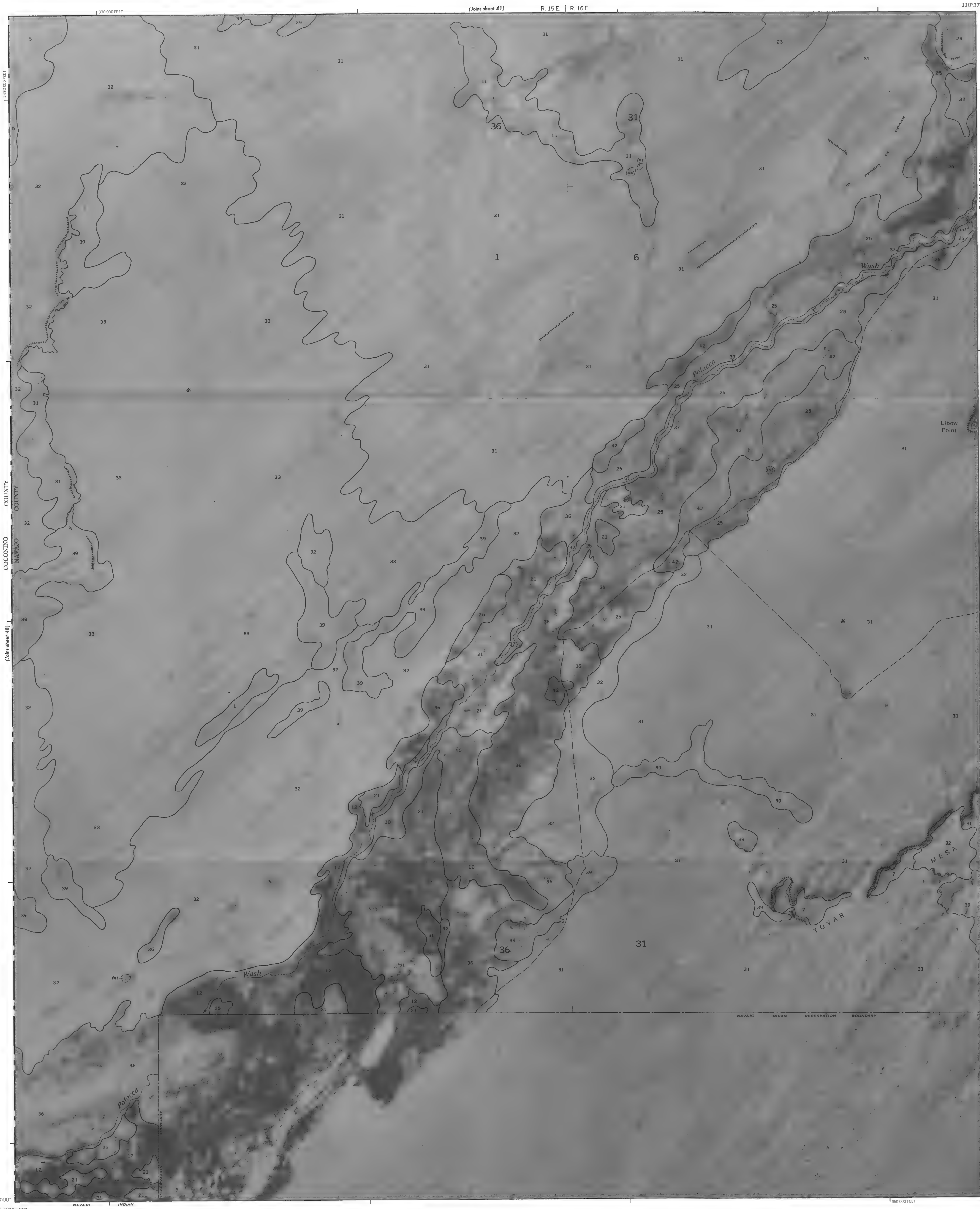
5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale 1:24 000

HOPI AREA, ARIZONA NO. 48

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY OF HOPI AREA, ARIZONA,
PARTS OF COCONINO AND NAVAJO COUNTIES



TOVAR MESA SW AZ

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000
N

HOPI AREA, ARIZONA NO. 49

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

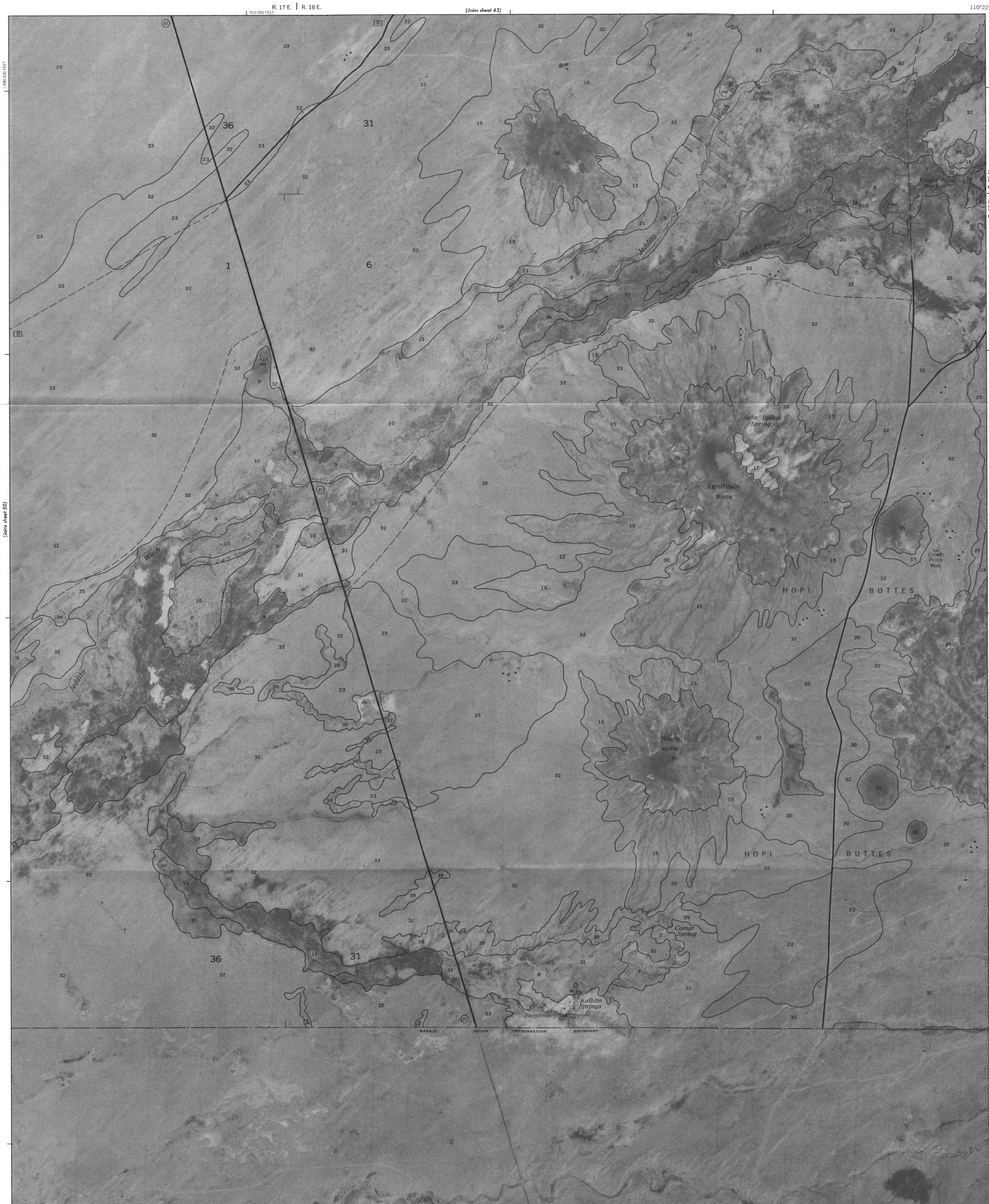
5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

1 .5 0 1 2 3 Kilometers

Scale - 1:24 000

HOPI AREA, ARIZONA NO. 50

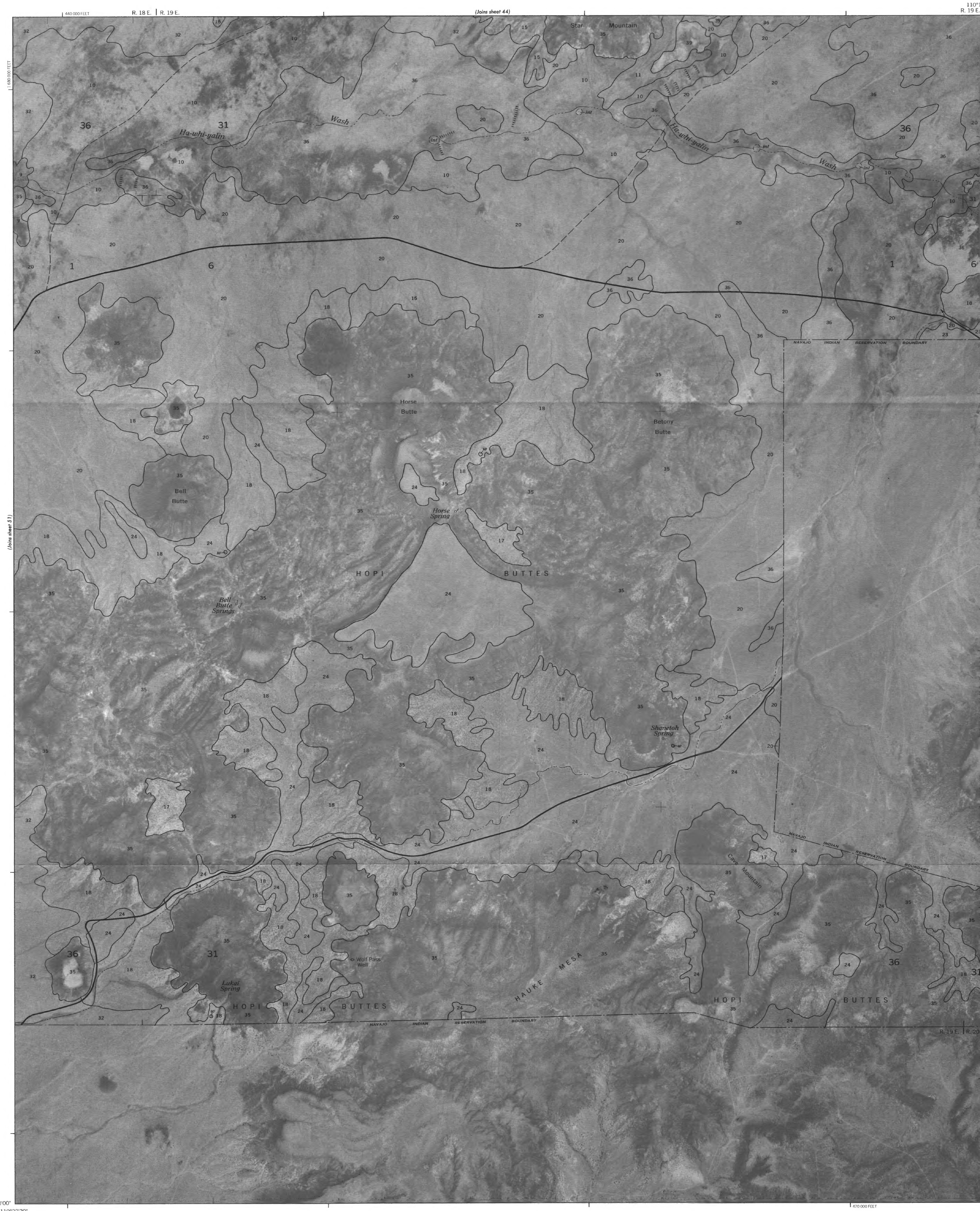
N



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24 000
HOPI AREA, ARIZONA NO. 51

N



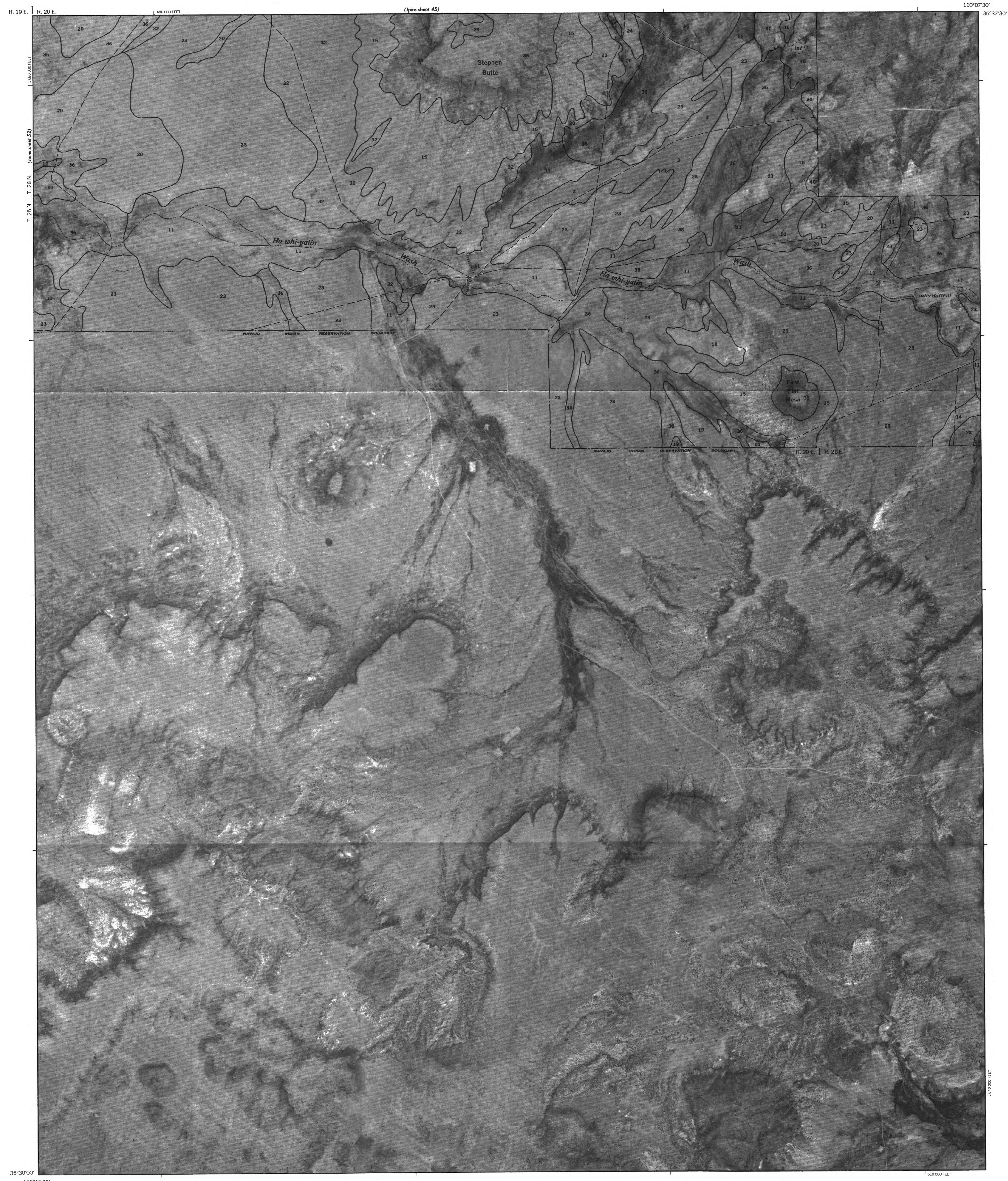
EGLOFFSTEIN BUTTE SE AZ

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 .5 0 1 2 3 Kilometers
Scale - 1:24000

HOPI AREA, ARIZONA NO. 52

N



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1973 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
1 .5 0 1 2 3 Kilometers
Scale 1:24 000

N

HOPI AREA, ARIZONA NO. 53